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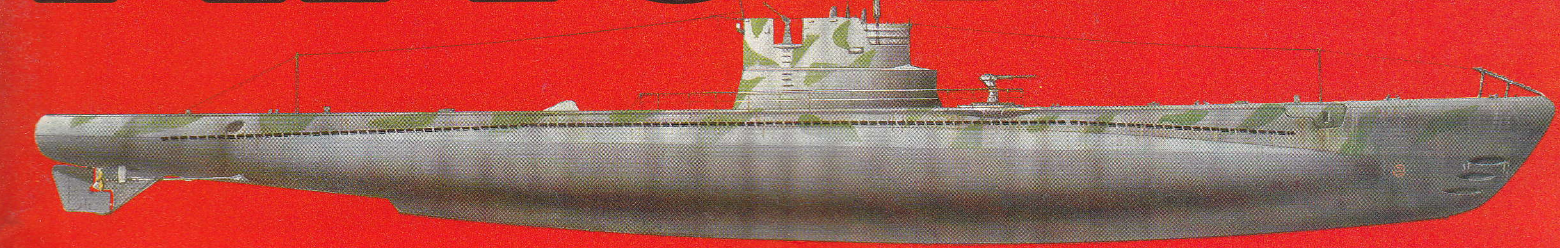

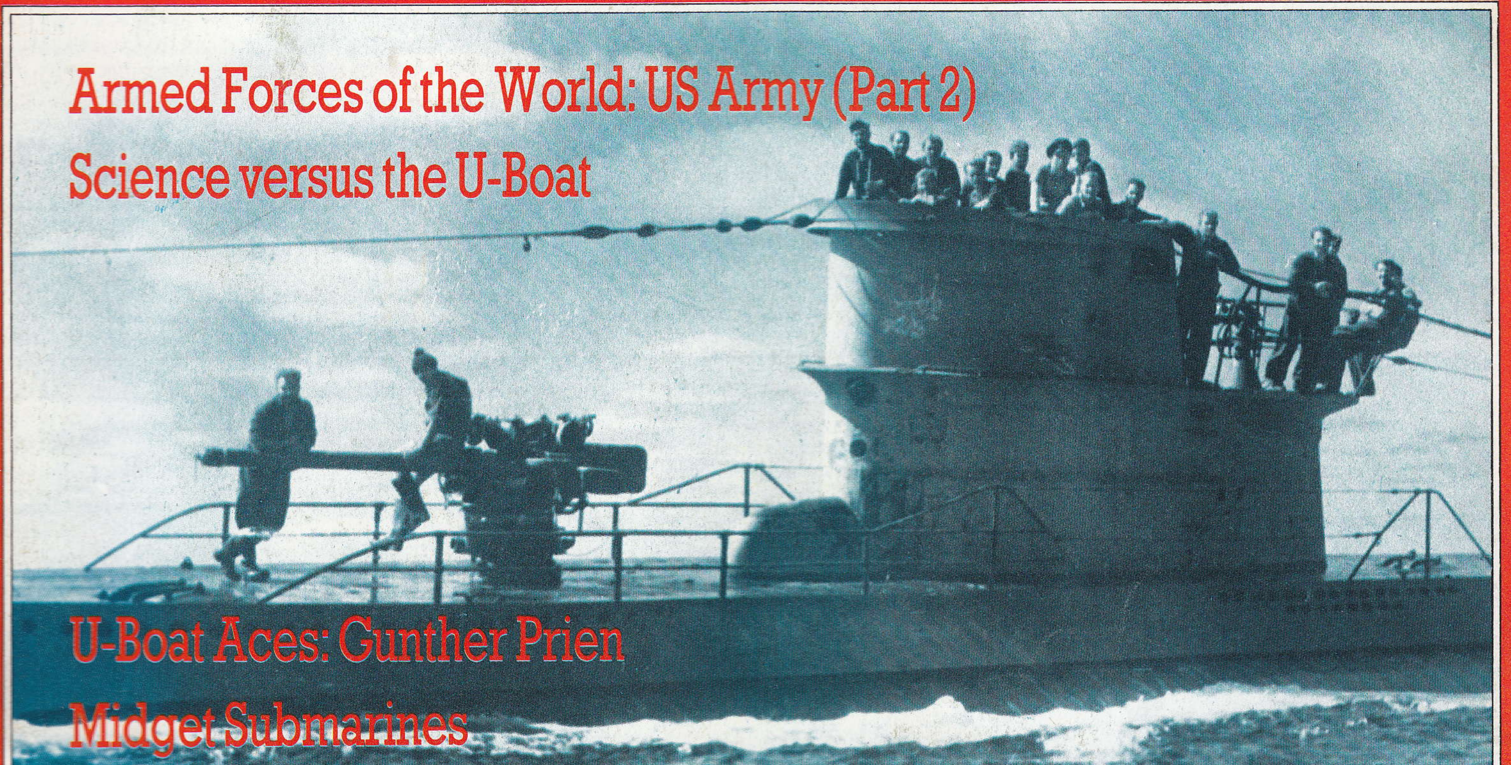

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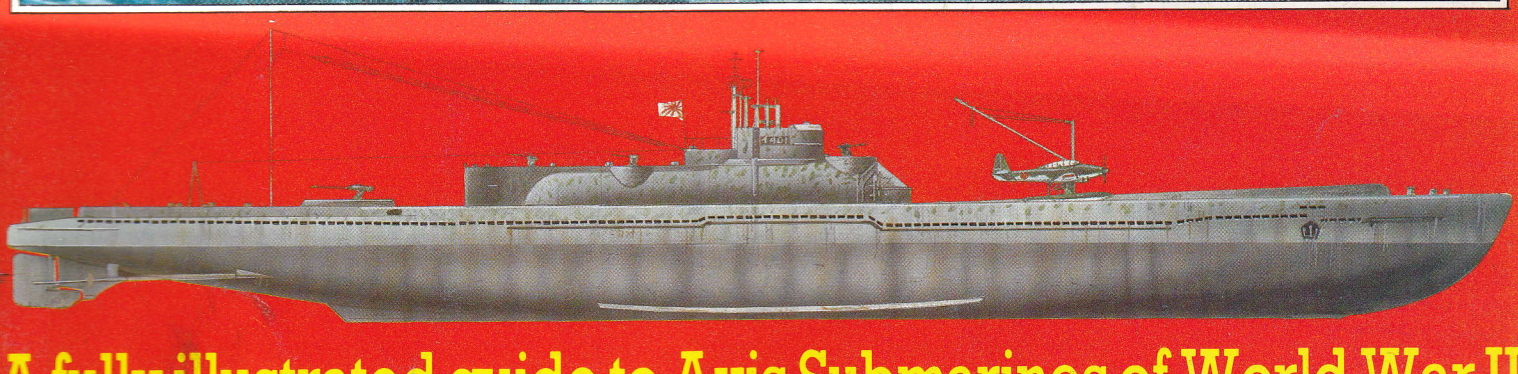

A fully illustrated guide to Axis Submarines of World War II

WAR MACHINE

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Axis Submarines of World War 11

A Krupp yard at Kiel, and construction of U-boats proceeds apace. German industry built more than 1100 boats, with well over half being lost in action. Of the remainder, most did not survive the war, being lost to accidents or to enemy action while in harbour.

The struggle for supremacy above and beneath the swirling waters of the North Atlantic was the most important battle fought by the submarine forces of the Axis navies, but was far from being the sole scene of operations. Indeed, Axis submarines ranged the sealanes from the Atlantic through the Indian Ocean to the South Pacific.

During World War II the common factor that permitted the USA to wage war in both Europe and the Pacific simultaneously, and which allowed the UK to exist at all, was merchant shipping. Losses of warships could cause problems, but losses of merchantmen were potentially disastrous. If the loss rate had exceeded the construction rate for a significant period, the Allies' capacity to wage war would have slowed, to the point eventually of capitulation.

As World War I had adequately proved to the Germans that submarines were the best vehicles for this form of warfare, it seems extraordinary that more resources were not put into their construction in the late 1930s. Those available caused damage enough, but greater numbers and a higher construction rate from the outset would have swamped the ability of current Allied defences to cope.

Throughout the conflict, the Germans strove to improve both the technical quality of their boats and the methods by which they could best be employed, a natural energy that contrasted strangely with that of their Axis partners. Both Italy and Japan had sizable submarine fleets and, as each joined the war at later dates, they had adequate time to learn at first hand the problems of submarine warfare before actually committing themselves.

Italy, however, found her boats to be deficient in quality and their crews both poorly trained and, in many cases, suffering from the same lack of motivation and conviction that affected her surface fleet.

Japan, on the other hand, had no lack of motivation but was stricken with an inflexibility of purpose that worked to the American advantage. War waged against merchant shipping was viewed as 'defensive' so, despite in most cases being manifestly unsuitable for the purpose, Japanese submarines were employed almost exclusively against warships. The twin facts that American lines of communication vulnerably straddled two oceans and that American submarines were throttling Japan by blockade appeared unnoticed.

There was no lack of sacrifice. In pursuing their various objectives, the Axis partners lost over 950 boats in action and many more from other causes.

Such was the pressure on Germany that the German navy could not afford to take obsolescent boats out of production, with the result that in the latter stages of the war boats such as U-805, a Type IXC/40, were badly outclassed in the struggle against the Allied escorts.

JAPAN

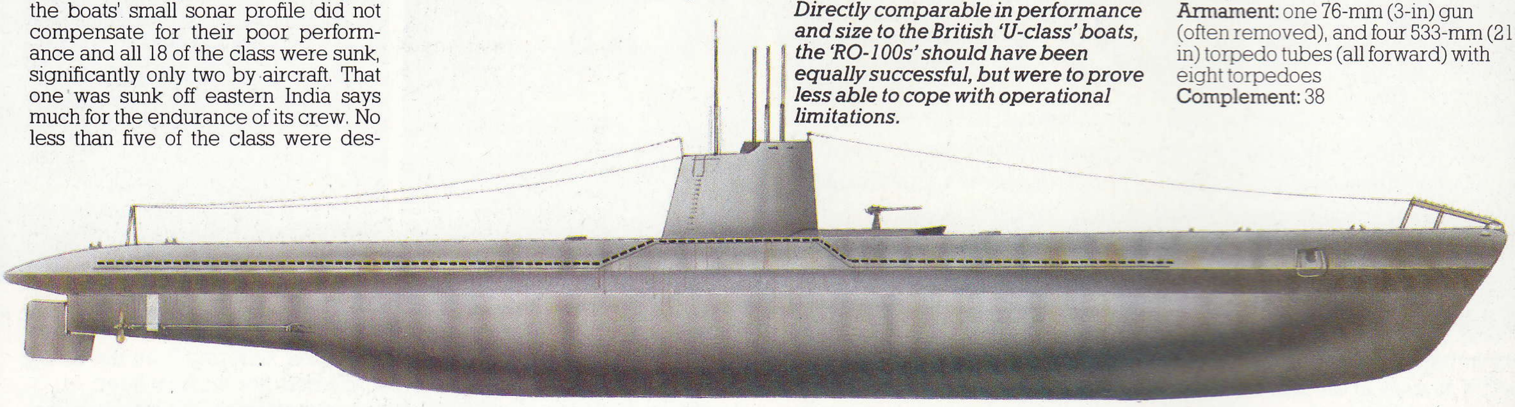
'RO-100' and 'RO-35' classes

Small- to medium-sized boats in the IJN were designated 'RO', equivalent to the Western 'B'. In the case of the **'RO-100' class**, the term **'Kaisho'** or **Type KS** was also used, denoting 'small'. They were designed originally as limited-endurance boats for use in the waters off the Japanese home islands, and for this reason operational depth could be reduced to only 75 m (245 ft). The function of the boats was, however, extended to protection of the numerous islands that were acquired to defend the outer perimeter of the new empire. As these were often surrounded by deep water, the 'RO-100' boats started at a disadvantage. Once submerged, the boats' small sonar profile did not compensate for their poor performance and all 18 of the class were sunk, significantly only two by aircraft. That one was sunk off eastern India says much for the endurance of its crew. No less than five of the class were destroyed by the American destroyer-escort USS *England* on various dates.

The design was a diminutive of, but very different from, the earlier 'RO-33'. In size and potential it equated roughly with the British U-class. They were unsuitable for attacking the warships that were designated their prime targets yet, whilst they could have operated effectively against mercantile targets, the Japanese submarine command showed the lack of imagination and flexibility that was characteristic throughout the war and which was primarily responsible for its poor showing.

The class of 18 was ordered pre-war but were being completed up to 1944. Nine further projected units were cancelled.

The parallel RO type, the **'RO-35' class ('Kaichu'** or **'Type K6')** was larger and comprised the last medium-sized boats built by the IJN. Of the 18 completed only one survived the war, having been used defensively despite their superior potential. Between them, the combined 'RO-35' and 'RI-100' classes are credited with four minor warships and six merchantmen sunk, a catastrophically poor rate of exchange that led also to the cancellation of 60 further 'RO-35s'.



Directly comparable in performance and size to the British 'U-class' boats, the 'RO-100s' should have been equally successful, but were to prove less able to cope with operational limitations.

Specification

'RO-100' class

Type: coastal submarine

Displacement: 601 tons surfaced and 782 tons submerged

Dimensions: length 60.90 m (199 ft 10 in); beam 6.10 m (20 ft 0 in); draught 3.50 m (11 ft 6 in)

Propulsion: surfaced diesels delivering 1,100 bhp (820 kW) and submerged electric motors delivering 760 hp (570 kW) to two shafts

Speed: surfaced 14 kts and submerged 8 kts

Range: surfaced 6500 km (4,040 miles) at 12 kts and submerged 110 km (68 miles) at 3 kts

Armament: one 76-mm (3-in) gun (often removed), and four 533-mm (21-in) torpedo tubes (all forward) with eight torpedoes

Complement: 38

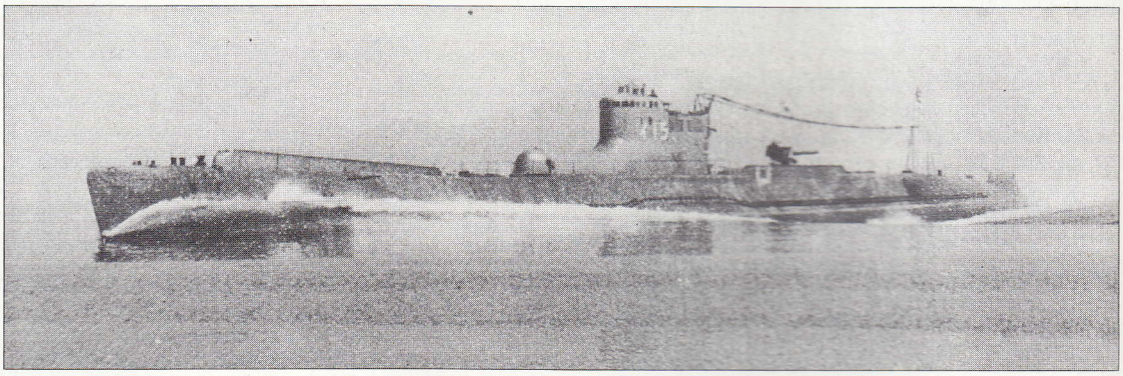
JAPAN

'I-15' class

An 'I' prefix, equivalent to the Western 'A', denoted a larger submarine designed for fleet or cruising work. These two functions were tending to merge, for the 'fleet' concept was a hangover from earlier British ideas of using large boats with a good surface performance to act closely as an element of the surface fleet, a concept that was not successful at that time. The **'I-15' class** was, therefore, derived from twin sources. First of these was the 'Type KD' fleet submarine of the mid-1930s, capable of a 23-kt surface speed and a range suitable for a return trip across the Pacific. The other was the 'Junsen', or cruiser submarine, of a slightly later date, which incorporated one or two floatplanes in a pressure-tight hangar forming part of the superstructure. It would seem that the idea of these aircraft was to increase the boat's scouting capability rather than for offensive purposes.

Really the first variant **'Type B1'** of three, the 'I-15' group was 20 strong, with the hangar a low, streamlined structure protruding (usually forward) from the tower. The freeboard was high to improve aircraft handling in a seaway, and was made higher by a sloping catapult track; a folding crane was also incorporated for recovery purposes. A 140-mm (5.5-in) gun was set on a substantial bandstand. In practice, the aircraft and its equipment proved more trouble than they were worth, and several boats had such provision removed in favour of a second gun to suit them better for the attack role. As such, the boats were among the more successful of Japanese classes, being credited with the sinking of eight warships (including the carrier USS *Wasp* by *I-19*) and 59 merchantmen of about 400,000 gross registered tons.

Despite these successes, the losses of the 'I-15' boats were catastrophically high, as a result mainly of their poor submerged performance and of the fact that only three full salvoes of torpedoes were carried; only one boat of 20 survived to surrender. A couple of the class, along with others from the very similar **'Type B2'** and **'Type B3'** variants, were modified to carry *Kaiten* (suicide midget submarines). The 'Type B2' was the **'I-40' class** (six completed) and the 'Type B3' was the **'I-54' class** (three completed).



This picture portrays the high surface speed of the Japanese Type B1 ('I-15') class. To improve targeting in the commerce-raiding role, a 'Glen' floatplane was carried.

Specification

'I-15' class

Type: ocean-going submarine

Displacement: 2,590 tons surfaced and 3,655 tons submerged

Dimensions: length 108.60 m (356 ft 4 in); beam 9.30 m (30 ft 6 in); draught 5.10 m (16 ft 9 in)

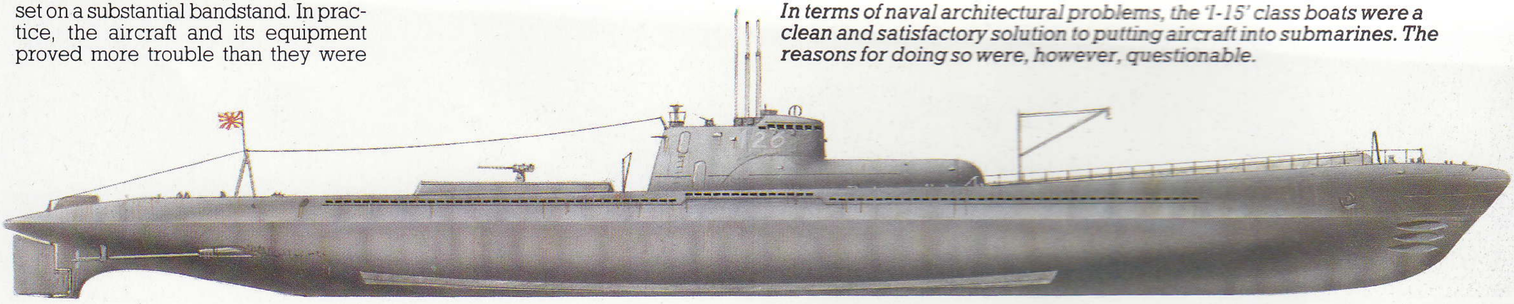
Propulsion: surfaced diesels delivering 12,400 bhp (9245 kW) and submerged electric motors delivering 2,000 hp (1490 kW) to two shafts

Speed: surfaced 23.5 kts and submerged 8 kts

Range: surfaced 26000 km (16,155 miles) at 16 kts and submerged 185 km (115 miles) at 3 kts

Armament: one 140-mm (5.5-in) gun, two 25-mm AA guns, one Yokosuka E14Y1 aircraft, and six 533-mm (21-in) torpedo tubes (all forward) with 17 torpedoes

Complement: 100



In terms of naval architectural problems, the 'I-15' class boats were a clean and satisfactory solution to putting aircraft into submarines. The reasons for doing so were, however, questionable.

Midget Submarines

Midget submarines were used by all the Axis navies with various degrees of enthusiasm and success. Types ranged from genuine but miniature submarines to the Japanese Kaiten *– manned suicide torpedoes.*

By their very nature, midget submarines possessed a 'cloak and dagger' aura that has tended to cause their true potential to be overrated. Like the Royal Navy, the fleets of all the major Axis powers operated them but, despite their odd success, they really did not repay the considerable effort expended on them in both design and construction. Philosophies regarding their use varied from fleet to fleet.

Like the British, the Italians saw them as means of attacking targets in difficult anchorages or for deploying specialist swimming teams. If the 16-m (52.5-ft) British X-craft are taken as a yardstick, they corresponded to the most-used of the Italian types, the CB. Several of these were transported overland to the Black Sea in 1942 and accounted for a pair of Soviet submarines, but little other activity is recorded. Smaller, 10-m (32.8-ft) CAs could carry either torpedoes or swimmers, depending on type. Prototypes for much larger, 33-m (108.27-ft) CC and CM types were built but never saw production.

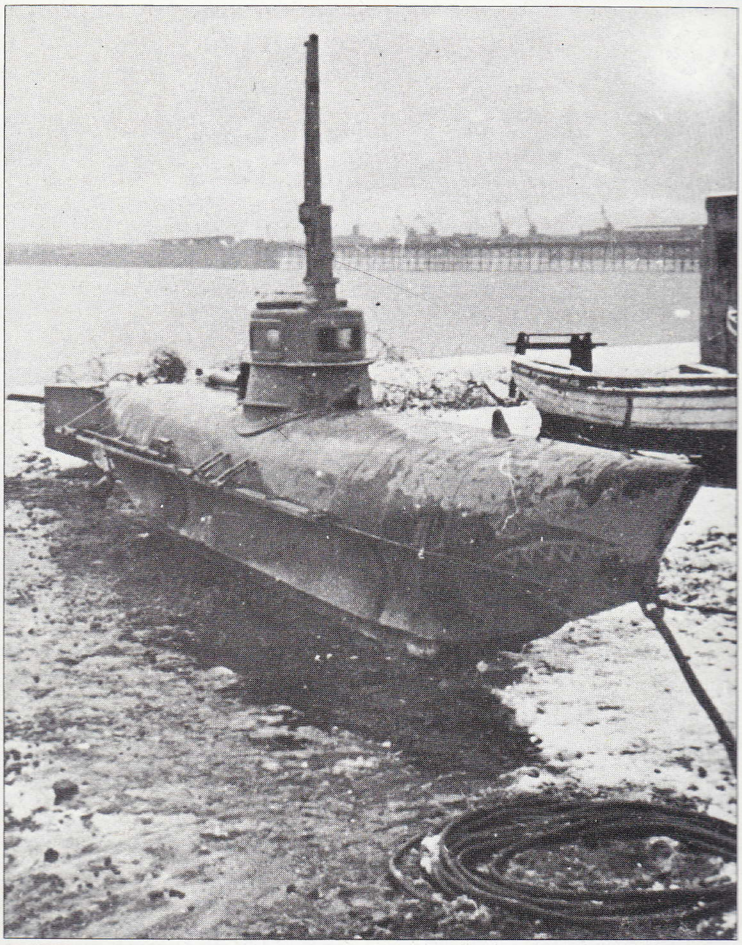
The Japanese had a far more ambitious use for midget submarines, seeing their role as being carried by surface ships and fleet submarines for launching in the course of a fleet action. With the speeds and ranges at which these were likely to be fought, this idea became manifestly impracticable and the midget boats were viewed more in the context of specialist attack and defence against enemy landings. About 400 were built to various designs, but only the 24-m (78.74-ft) Type As were used at all effectively, although their debut during the Pearl Harbor attack was far from auspicious.

Following the occupation of Madagascar by the British some six months later, however, naval forces were reconnoitred by a Japanese seaplane. Despite this warning, the battleship HMS *Ramillies* and a tanker were afterwards torpedoed in sheltered waters off Diego Suarez. The battleship survived but was considerably damaged. The attack had been carried out by Type As which, with the seaplane, had been carried on three Japanese submarines. This well integrated operation was followed a day later by an unsuccessful attempt on Sydney Harbour in Australia.

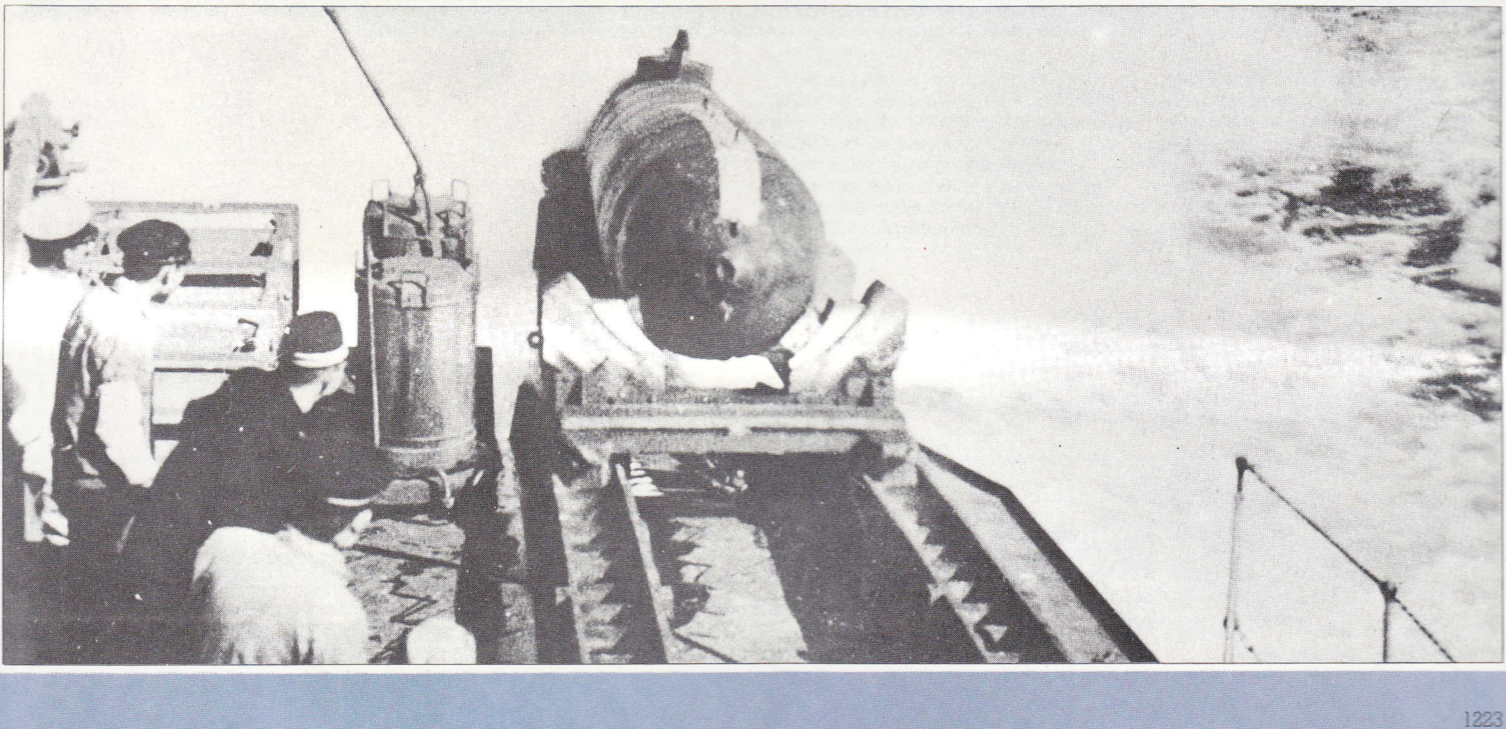
Predictably, the Japanese produced a suicide torpedo, the *Kaiten*, toward the end of the war. These were to be used in large numbers, launched from submarines and surface ships. Fortunately, their steering was as suspect as the dedication of many of their pilots.

The Germans built a wide range of torpedo-carrying midgets for use against amphibious landing fleets. The Neger and Marder each had one, and the Biber two, 533-mm (21-in) torpedoes, the latter being able to carry them for 240 km (149 miles) at 6 kts. Built in quantity and transported overland, they were in action off Anzio, Normandy and the Schelde, but found the Allied escorts plentiful, aggressive and more than able to cope. Many of the little craft just went missing.

Potentially more effective were the true submarines of the Type XXVIIA (Hecht) and Type XXVIIB (Seehund) classes. These were 10.5 and 12 m (34.4 and 39.4 ft) long respectively, and the latter had two torpedoes and a 550-km (342-mile) range. This was sufficient to reach the British east coast but, again, they could do little more than sink the odd one or two merchantmen. Kept well in check by the anti-submarine forces, their challenge finally died with the liberation of the Channel coasts by Allied forces.



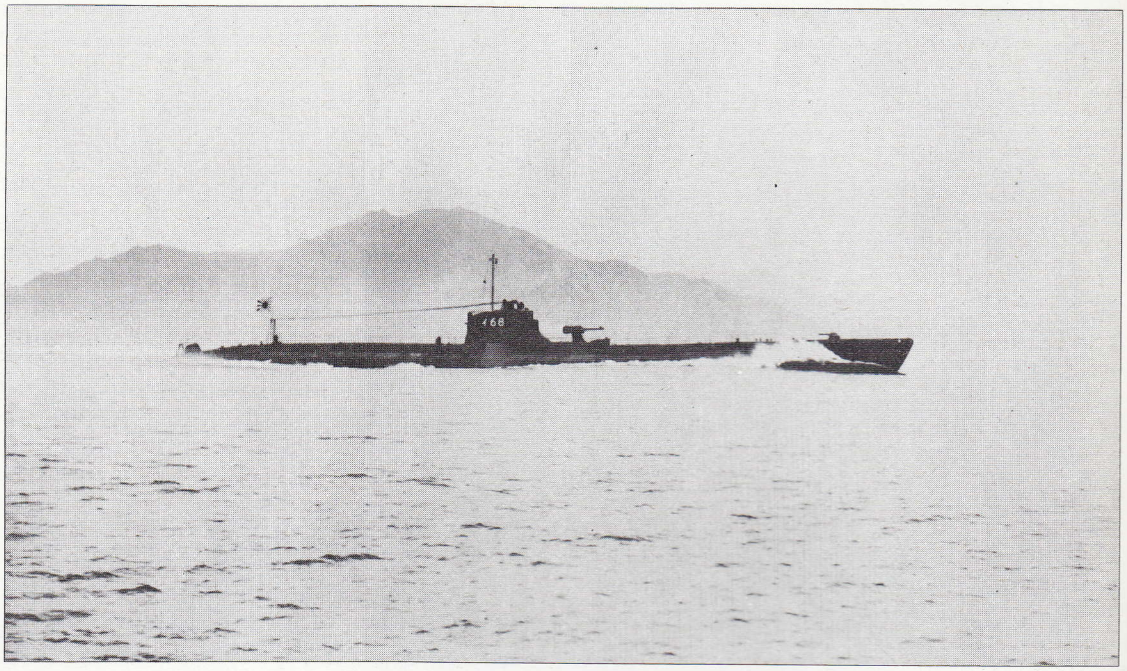
One of several types of 'Small Battle Unit', the Biber (Beaver) displaced only six tons. The picture shows the scalloped hull which could carry two torpedoes or two mines. At the forward end is a towing point which allowed the rather short-ranged craft to be towed to a point near its operational area.



A Kaiten 1 *is launched from a converted light cruiser. The pilot was housed within a remodelled Type 93 torpedo, and was supposed to control it at 30 kts to a target that can scarcely have been visible. Later versions, to have used hydrogen peroxide engines, would have been truly suicidal in use.*

JAPAN

'I-361', I-373' and 'I-351' classes



Similar in size to the 'I-361' class, some of the 'KD6a' class of attack submarine were converted to transports, the gun being removed and a 13-m (42.7-ft) landing craft carried in place of spare torpedoes. 'I-68' (re-numbered 'I-168') was sunk in May 1943.

The well-recorded exploits of the 'Tokyo Express' to Guadalcanal tend to overshadow the fact that the Japanese had many other island garrisons that needed support and resupply. Once the American counteroffensive began to make progress in 1943, many such islands were bypassed as having low strategic significance. With the enemy firmly across their lines of supply, Japanese surface forces (even if available) would have had little chance of survival in such a role, so the supplementary 1942 building programme included a dozen specialist cargo-carrying submarines, known as the **'Type D1'** or **'I-361' class** after the first such unit. Though not large, the boats were ungainly, their high casing acting as a stowage for two 13-m (42.7-ft) landing craft abaft the fin. These were built to resist diving to 60 m (197 ft) and could be floated on and off by trimming the submarine. Twenty tons of stores could also be carried externally with a further 60 tons and two large rubber boats inboard. Alternatively 110 equipped men could be carried on short hauls.

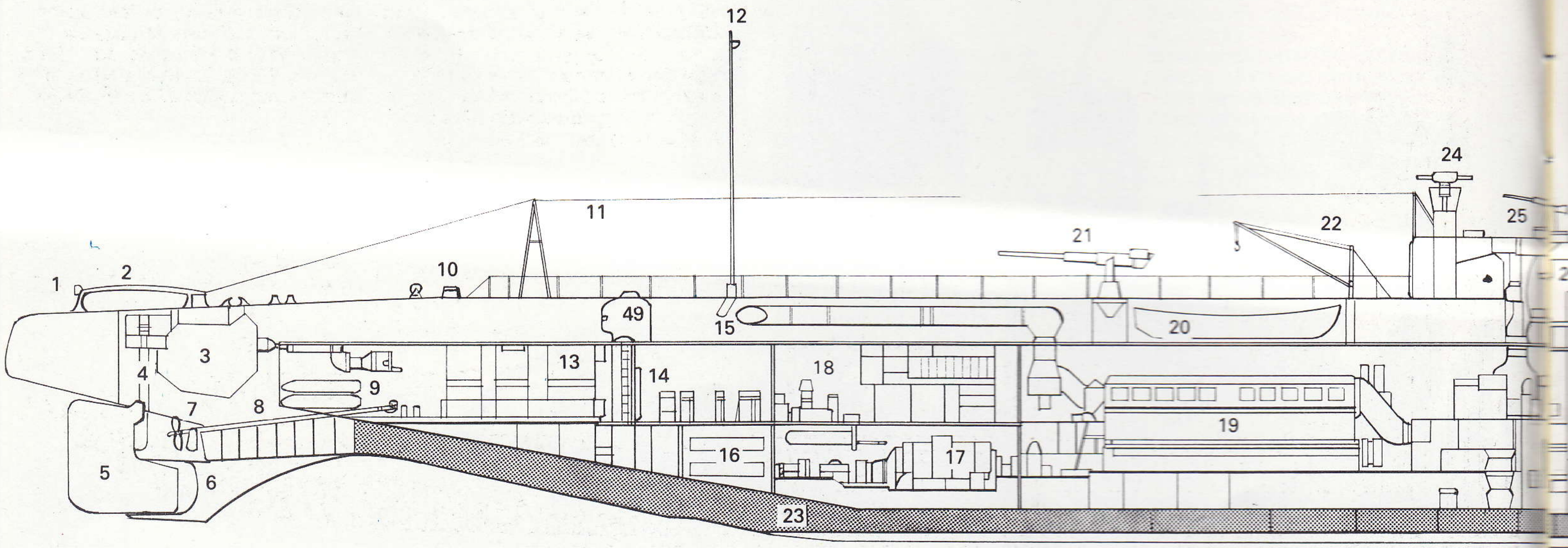
By Japanese standards the boats' submerged endurance was good, but their 60-day surfaced endurance was excessive, as resupply over the radius of which the boats were capable would have required many more of the class. Though they boasted a 140-mm (5.5-in) gun, the boats had no torpedo tubes, the two fitted in early units being removed in an effort to improve poor handling characteristics. Once detected, therefore, the boats were particularly vulnerable and nine were lost. The **'Type D2'** or **'I-373' class** exchanged endurance for further stowage, but went to only two boats before being overtaken by events. Five of the 'Type D1' boats were eventually converted to *Kaiten* (suicide midget submarine) carriers.

More ambitious were the three **'I-351' class** boats, known also as the **'Type SH' for 'Sen Ho'** or 'submarine replenisher'. Some 111 m (364.2 ft) in length, these were the equivalent of the German Type XIV *Milchkühe*. They had triple hulls, between two of which could be stowed about 600 tons of aviation spirit for the refuelling of long-range flying-boats. Inboard was stowed a comprehensive range of stores, ordnance and even spare crews. Only one was ever completed.

Specification
'I-361' class
Type: supply submarine
Displacement: 1,440 tons surfaced and 2,215 tons submerged
Dimensions: length 73.40 m (240 ft 10 in); beam 8.90 m (29 ft 2 in); draught 4.70 m (15 ft 5 in)
Propulsion: surfaced diesels delivering 1,850 bhp (1380 kW) and submerged electric motors delivering 1,200 hp (895 kW) to two shafts
Speed: surfaced 13 kts and submerged 6.5 kts
Range: surfaced 27900 km (17,335 miles) at 10 kts and submerged 220 km (137 miles) at 3 kts
Armament: one 140-mm (5.5-in) gun, and two 25-mm AA guns
Complement: 70

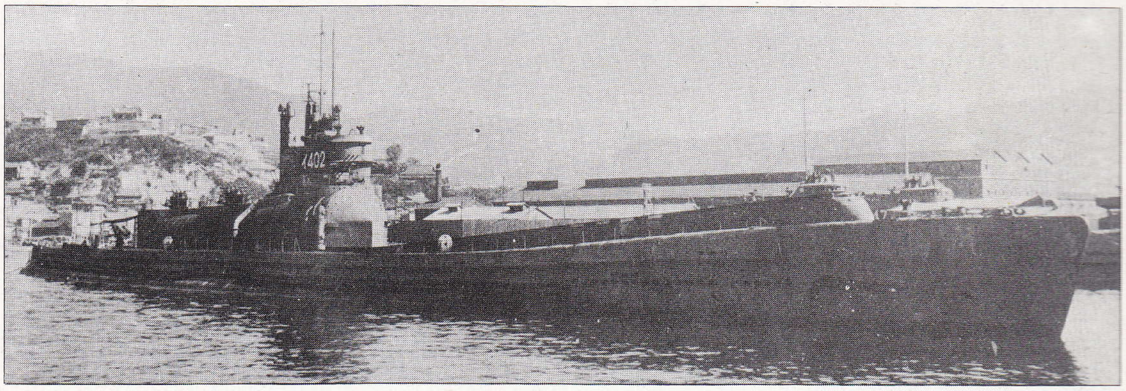
'I-58' cutaway drawing key

1 Aft navigation light
2 Auxiliary rudder
3 Rudder engine
4 Spindle
5 Main rudder
6 Rudder support
7 Screw
8 Propeller shaft
9 Compressed air canisters
10 Loading hatch
11 Wireless aerial
12 Navigation light
13 Crew quarters
14 Watertight doors
15 Diesel exhaust
16 Compressed air compartment
17 Electric motor
18 Engine room
19 Diesel engine
20 Stowed dinghy
21 140-mm (5.5-in) deck gun
22 Collapsible derrick for handling dinghy
23 Double hull
24 Optical rangefinder
25 25-mm AA gun
26 Ammunition hoist
27 Periscopes
28 Radio direction finder
29 Enclosed conning tower
30 Control room
31 Stores
32 Magazine
33 Periscope wells
34 Auxiliary engine
35 Hangar
36 Watertight door to hangar
37 Torpedo loading hatch
38 Officers' quarters
39 Batteries
40 Collapsible derrick for handling floatplane
41 Yokosuka E14Y reconnaissance floatplane (codenamed 'Glen')
42 Anchor handling gear
43 Catapult track
44 Anchor
45 Spare torpedoes (21 in)
46 Torpedo tubes
47 Torpedo trolley
48 Pressure hull
49 Escape compartment
50 Radio room



JAPAN

'I-400' class



Above: The large aircraft-carrying submarine 'I-402', despite any external evidence, had been converted to a submersible tanker for replenishing isolated garrisons. Up to three small floatplanes could be housed in the very long hangar.

Unable to strike effectively at strategic targets on the US west coast, the Imperial Japanese Navy conceived the idea of submarines carrying a pair of bomber floatplanes. Because of the accommodation for these and the ranges involved, the resultant boat would need to be large, with considerable beam as well as length to minimize ship motion during aircraft operations. A capacious hull could be used to add accommodation, and the aircraft would also be employed as scouts. Thus the resultant **'I-400' class** design, known officially as the **'Type STo'** for **'Sen-Toku'** or 'special submarine', was expected to combine several functions in control, attack and reconnaissance. The length was about 122 m (400.3 ft), and a satisfctory length to beam ratio would have involved an unacceptably deep hull if constructed as a single cylinder; the pressure hull was, therefore, constructed as a horizontal figure eight in section, reinforced for a useful operational diving depth of 100 m (328 ft). Like that of most Japanese boats, submerged performance was not particularly good and, with operations on the American seaboard in mind, the boats were equipped with a crude, fixed snorkelling device.

The hangar was a separate pressure cylinder, accessible from within the hull, tilted slightly to the slope of the catapult track running the length of the foredeck. As completed, the boats had an aircraft complement of three. The hangar was sited on the centreline, and the long bridge structure on top needed to be offset to port, its length being reminiscent of the British 'K' boats of World War I.

The beam of the boats allowed for two diesels on each shaft driving through a common gearbox, but the 'I-400' class units must have been a problem to dive and handle once submerged. In the event, like the broadly similar 'I-13' class boats, their priority lapsed and only three were ever completed, another two being started. They found no employment (though one was converted as a fuel carrier) and all were scuttled by the Americans after the war. Like so many special-purpose warships, their need passed with their promoters.

Specification

'I-400' class

Type: ocean-going submarine

Displacement: 5,223 tons and 6,560 tons submerged

Dimensions: length 121.90 m (400 ft 0 in); beam 12.00 m (39 ft 4 in); draught 7.00 m (23 ft 0 in)

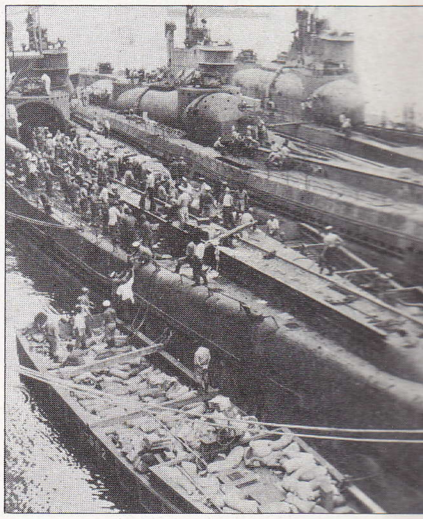
Propulsion: surfaced diesels delivering 7,750 bhp (5780 kW) and submerged electric motors delivering 2,400 hp (1790 kW) to two shafts

Speed: surfaced 19 kts and submerged 7 kts

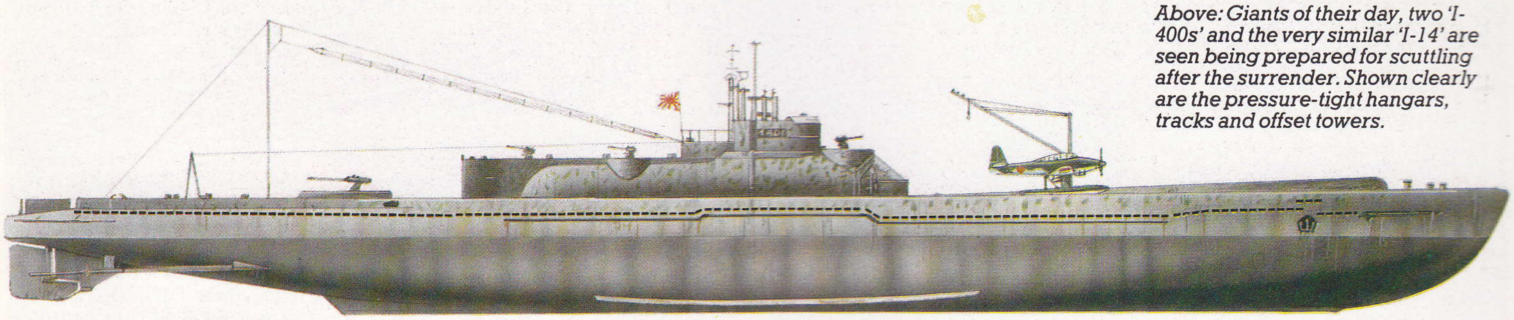
Range: surfaced 7000 km (4,350 miles) at 14 kts and submerged 110 km (68 miles) at 3 kts

Armament: one 140-mm (5.5-in) gun, 10 25-mm AA guns, three Aichi M6A1 aircraft (with torpedoes and bombs), and eight 533-mm (21-in) torpedo tubes (all forward) with 20 torpedoes

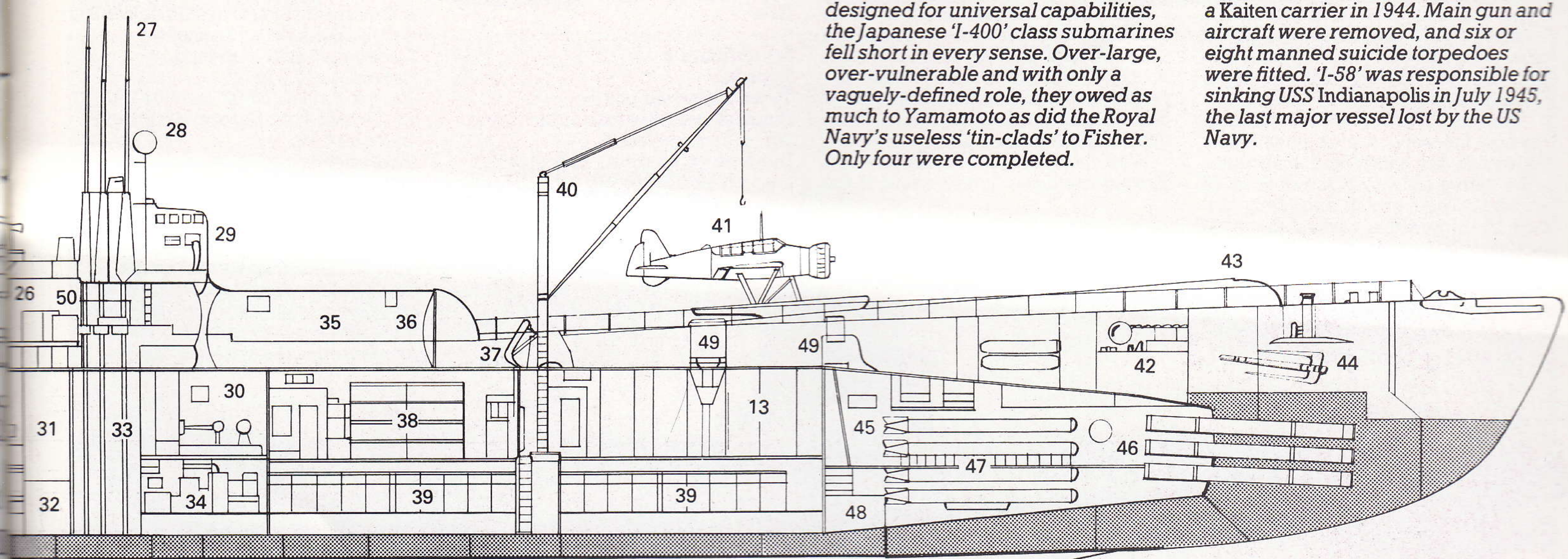
Complement: 140 including flight detachment



Above: Giants of their day, two 'I-400s' and the very similar 'I-14' are seen being prepared for scuttling after the surrender. Shown clearly are the pressure-tight hangars, tracks and offset towers.



Above: Like a number of projects designed for universal capabilities, the Japanese 'I-400' class submarines fell short in every sense. Over-large, over-vulnerable and with only a vaguely-defined role, they owed as much to Yamamoto as did the Royal Navy's useless 'tin-clads' to Fisher. Only four were completed.



Below: 'I-58' prior to conversion into a Kaiten carrier in 1944. Main gun and aircraft were removed, and six or eight manned suicide torpedoes were fitted. 'I-58' was responsible for sinking USS Indianapolis *in July 1945, the last major vessel lost by the US Navy.*

JAPAN

'Ha-201' class

Technically the most interesting of Japan's many submarine designs, the little **'Ha-201' class** boats, complemented by the 78-m (255.9-ft) 'I-201' class boats, were the equivalent of the German Types XXIII and XXI respectively. With the Americans pressing ever closer to the home islands, the Japanese seem in 1943 at last to have grasped the fact that they had the wrong types of submarine to tackle their chosen prime targets, warships. Their strategy would best have been served by concentrating their existing boats, as did the Americans, on mercantile targets but, persevering to the end, the Japanese developed the 'Ha 201' class or **'Type STS'** as a fast, manoeuvrable design to protect the home islands against warships. Like similar German boats, however, they arrived too late to be of use, their enemy already having achieved absolute superiority.

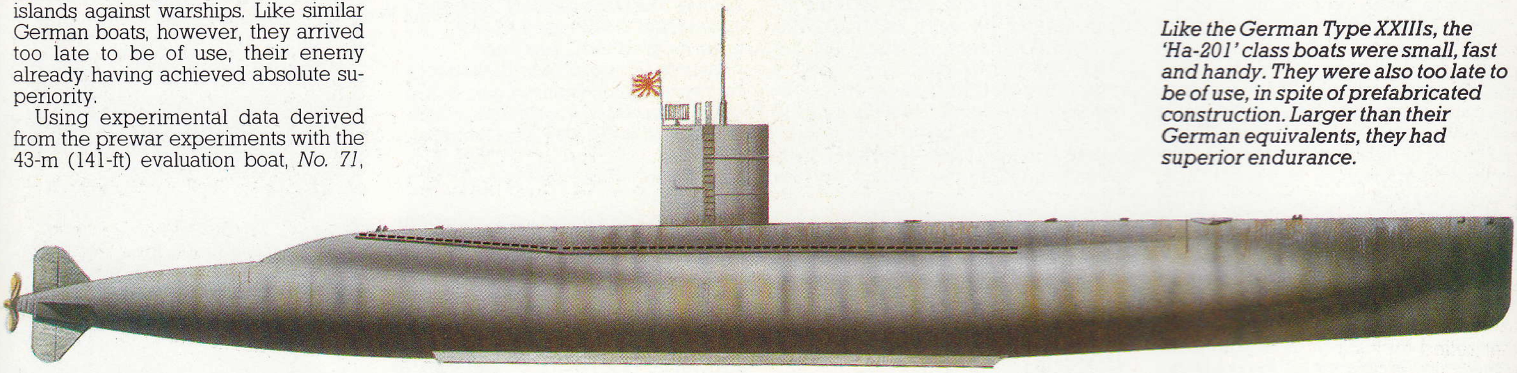
Using experimental data derived from the prewar experiments with the 43-m (141-ft) evaluation boat, *No. 71*, the Japanese planned the rapid production of 90 boats. Even with extensive prefabrication and the use of five separate yards, they managed to complete only about 10, none of which managed an offensive patrol, though 28 more were in an advanced state of construction at the surrender.

The prefix 'Ha' corresponds to 'C', denoting a small boat. The exterior was kept as clean of protruberances as possible, though there was rather a lot of forward casing. The boats were capable of 'grouping-up' for limited bursts of high submerged speed, necessary as they had only two torpedo tubes and attacks needed to be carried out from close range to guarantee success. Interestingly, they were propelled by a single, centreline propeller, set abaft a cruciform control surface assembly, remarkably similar to modern arrangements. They possessed only limited endurance and their crew of 22 could be supported for about 15 days. A type of snort was fitted to allow prolonged periods of submersion, necessary for them to survive at a time when American air power was virtually unchallenged. Together with advanced German submarine types, they yielded the Americans much valuable post-war data to apply to their 'Guppy' programmes.

Specification

'Ha-201' class
Type: coastal submarine
Displacement: 377 tons surfaced and 440 tons submerged
Dimensions: length 53.00 m (173 ft 11 in); beam 4.00 m (13 ft 1 in); draught 3.40 m (11 ft 2 in)
Propulsion: surfaced diesel delivering 400 bhp (298 kW) and submerged electric motor delivering 1,250 hp (930 kW) to one shaft
Speed: surfaced 10.5 kts and submerged 13 kts
Range: surfaced 5600 km (3,480 miles) at 10.5 kts and submerged 185 km (115 miles) at 2 kts
Armament: one 7.7-mm (0.303-in) machine-gun, and two 533-mm (21-in) torpedo tubes (both forward) with four torpedoes
Complement: 22

Like the German Type XXIIIs, the 'Ha-201' class boats were small, fast and handy. They were also too late to be of use, in spite of prefabricated construction. Larger than their German equivalents, they had superior endurance.

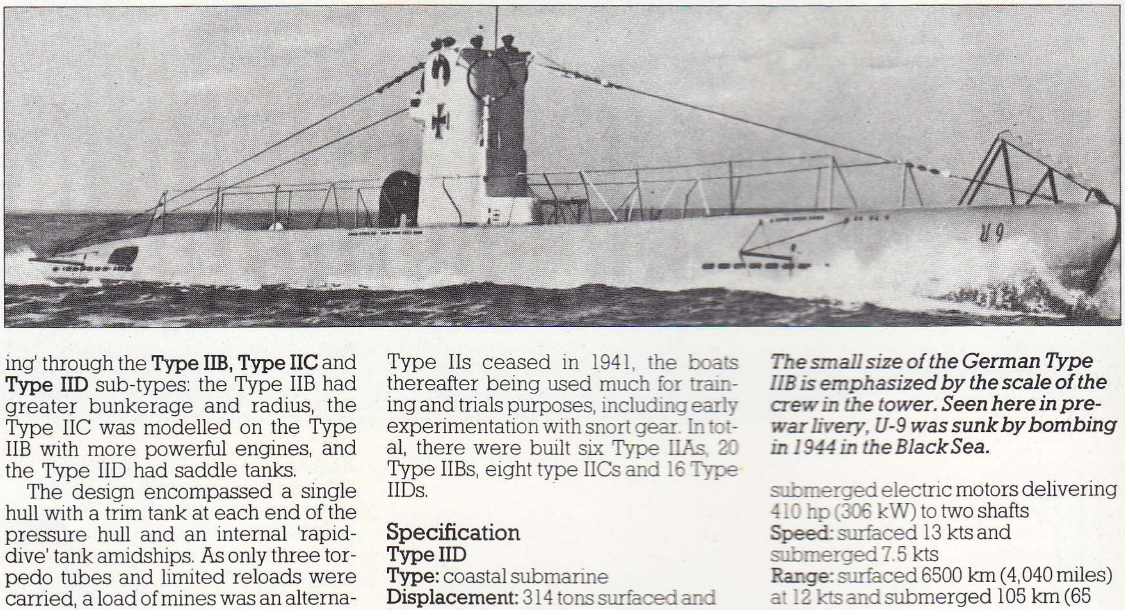


GERMANY

Type II

In 1935 Germany repudiated the treaty by which she was prevented from operating submarines, forcing an Anglo-German agreement which allowed direct construction up to a ceiling of total tonnage equivalent to 45 per cent of that operated by the British. A major task for the submarine supremo, Karl Dönitz, was to break this figure down into numbers and types of boat that would fulfil a wartime strategy. One requirement identified was that of a coastal submarine roughly equivalent to the later UB series that operated successfully in UK waters during World War I. During the fallow years of the treaty, German design expertise was maintained through work for export, and the prototype for the **Type IIA** can thus be found in the *Vesikko*, itself based on an amalgam of data from the UBII and the later UF. This boat was built in Finland in 1933 to German design.

The Type IIAs went quickly into production following the go-ahead, and proved to be handy and manoeuvrable, being able to crash-dive in 25 seconds. Their profile and lively surface characteristics earned them the nickname of 'canoes'. Though the small displacement of the Type IIA favoured larger numbers in a restricted ceiling, the design was very limited on endurance, requiring progressive 'stretching' through the **Type IIB, Type IIC** and **Type IID** sub-types: the Type IIB had greater bunkerage and radius, the Type IIC was modelled on the Type IIB with more powerful engines, and the Type IID had saddle tanks.



The small size of the German Type IIB is emphasized by the scale of the crew in the tower. Seen here in pre-war livery, U-9 was sunk by bombing in 1944 in the Black Sea.

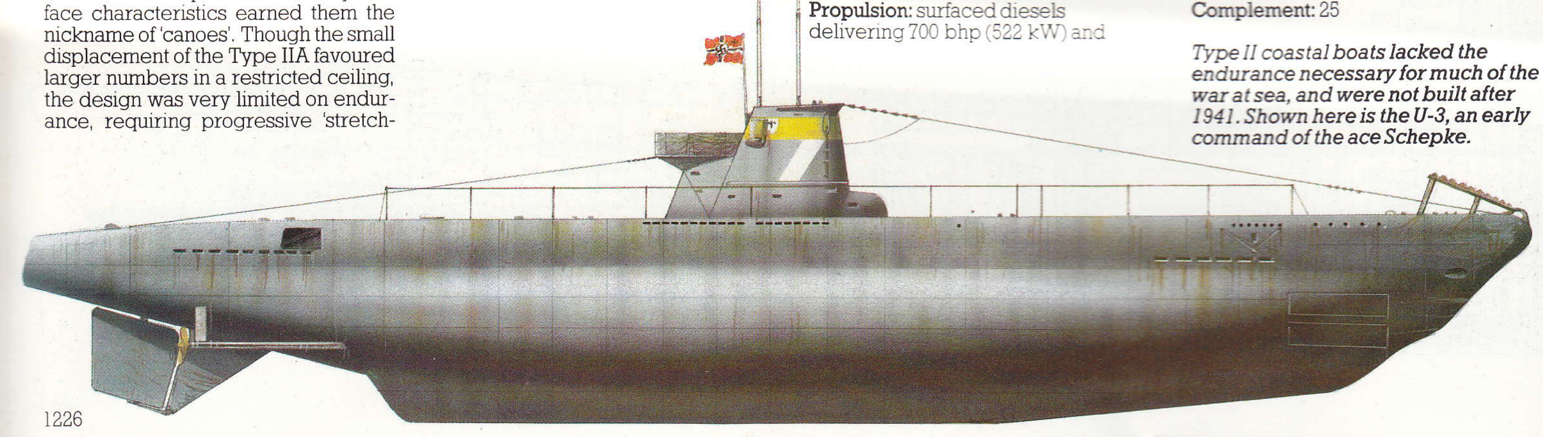
The design encompassed a single hull with a trim tank at each end of the pressure hull and an internal 'rapid-dive' tank amidships. As only three torpedo tubes and limited reloads were carried, a load of mines was an alternative rather than an addition.

With the emphasis of the sea war moving deep-sea, construction of the Type IIs ceased in 1941, the boats thereafter being used much for training and trials purposes, including early experimentation with snort gear. In total, there were built six Type IIAs, 20 Type IIBs, eight type IICs and 16 Type IIDs.

Specification

Type IID
Type: coastal submarine
Displacement: 314 tons surfaced and 364 tons submerged
Dimensions: length 43.95 m (144 ft 2 in); beam 4.87 m (16 ft 0 in); draught 3.90 m (12 ft 9 in)
Propulsion: surfaced diesels delivering 700 bhp (522 kW) and submerged electric motors delivering 410 hp (306 kW) to two shafts
Speed: surfaced 13 kts and submerged 7.5 kts
Range: surfaced 6500 km (4,040 miles) at 12 kts and submerged 105 km (65 miles) at 4 kts
Armament: one (later four) 20-mm AA guns and three 533-mm (21-in) torpedo tubes (all forward) with six torpedoes
Complement: 25

Type II coastal boats lacked the endurance necessary for much of the war at sea, and were not built after 1941. Shown here is the U-3, an early command of the ace Schepke.

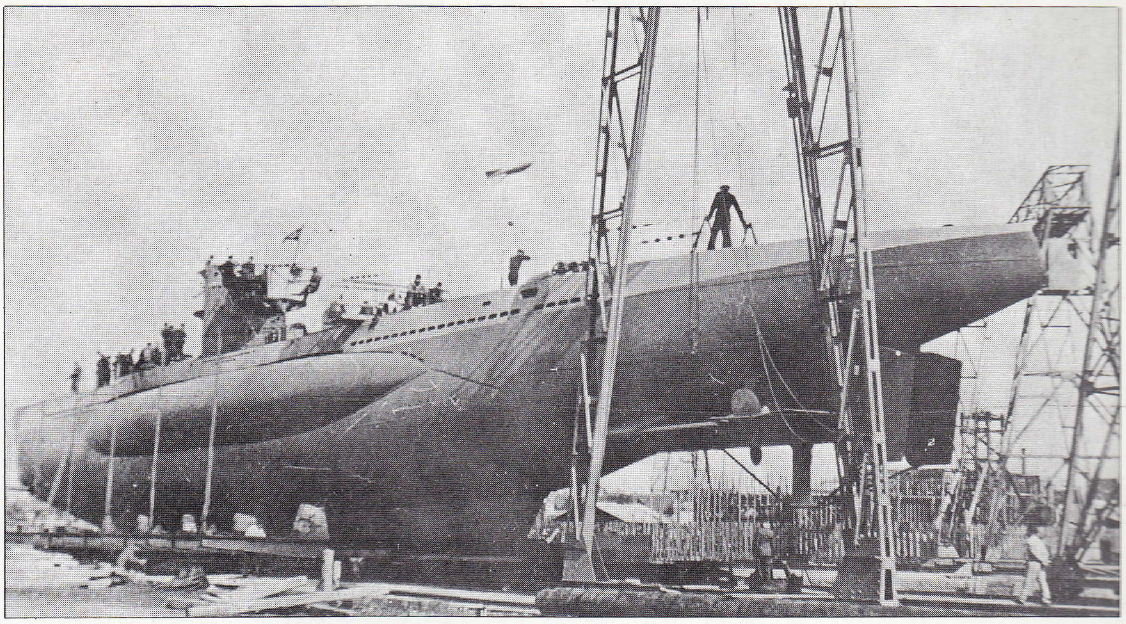


GERMANY

Type VII

Like that of the Type II, the design of the **Type VII** seagoing boat had export origins in a Finnish-built series of 1930-1 (the 'Vetehinen' class) and, beyond that, in the UB III of 1918. To permit the greatest number of hulls to be built within the ceiling tonnage agreed, size was severely limited in the 10 **Type VIIA** boats (626/745 tons). With performance and offensive capacity optimized, conditions aboard were somewhat spartan even with internal space saved by mounting the after tube in the casing (where it could be reloaded only with difficulty and then on the surface) and by the stowage of spare torpedoes and part of the bunker capacity externally (where they were vulnerable to depth charging). The **Type VIIB** and **Type VIIC** were, therefore, stretched to increase internal volume to rectify some of the shortcomings and to allow more powerful diesels to be fitted, a significant factor in surface operations. This modified boat was highly successful, nearly 700 units being built in various sub-variants until the war's end. Later improvements included greater operational depths, reinforced towers, enhanced AA armament and snorts, all features reflecting developing Allied anti-submarine procedures. Significantly, most lacked a deck gun as surface operations became impossible.

While mines configured to the standard 533-mm (21-in) torpedo tube could be laid by all German submarines, these weapons could not guarantee a sinking as opposed to disablement. To lay the largest moored mines, therefore, six Type VIIs were stretched by the addition of an extra 10-m (32.8-ft) section amidships containing five vertical free-flooding tubes, each containing three complete mine assemblies. These tubes protruded upward to 01 level into an extended tower. The class was known as the **Type VIID**. A further four boats, the **Type VIIF** sub-class, were similarly lengthened, with the additional space given over to spare torpedoes for transfer to extend the operational duration of other boats. Up to 25 torpedoes could be carried but transfer operations with both boats temporarily immobilized on the surface became increasingly upopular and were abandoned. The **Type VIIE**, a study in improved propulsion, never progressed beyond the drawing board.

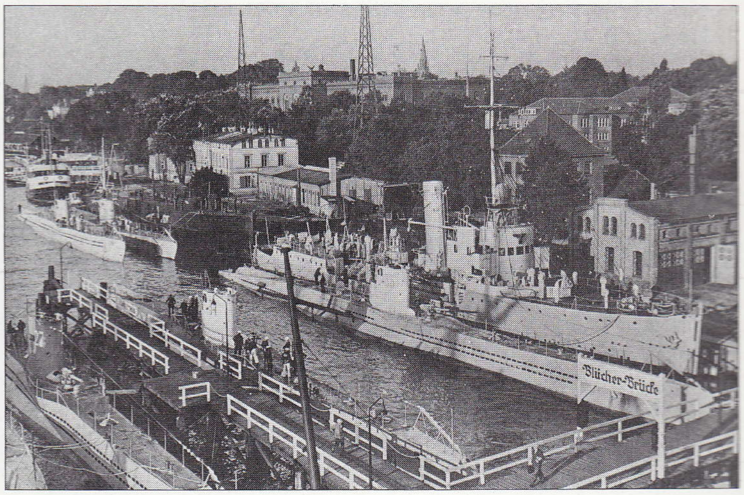


Above: A Type VIIC boat, probably U-402, is re-launched after maintenance, her broad keelson allowing her to sit on the cradle with little auxiliary support. Note the blisters of the external ballast tanks and the skeg aft spreading braces to keep wires clear of the twin rudders.

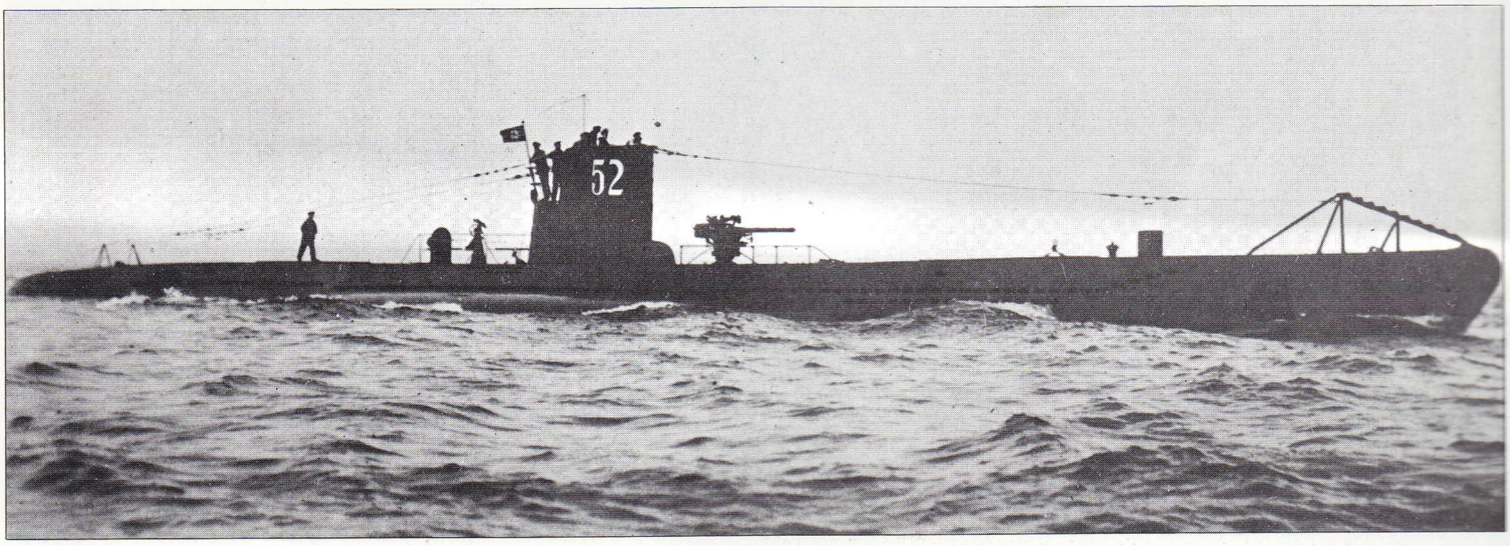
Specification

Type VIIC
Type: sea-going submarine
Displacement: 769 tons surfaced and 871 tons submerged
Dimensions: length 66.50 m (218 ft 2 in); beam 6.20 m (20 ft 4 in). draught 4.75 m (15 ft 7 in)
Propulsion: surfaced diesels delivering 2,800 bhp (2089 kW) and submerged electric motors delivering 750 hp (559 kW) to two shafts
Speed: surfaced 17.5 kts and submerged 7.5 kts
Range: surfaced 15750 km (9,785 miles) at 10 kts and submerged 150 km (93 miles) at 4 kts
Armament: one 88-mm (3.465-in) gun, one 37-mm AA gun, two (later eight) 20-mm AA guns, and five 533-mm (21-in) torpedo tubes (four forward and one aft) with 14 torpedoes
Complement: 44

Below: A clutch of Type VIIA boats of the Second Flotilla alongside at Kiel prewar. The tender is the converted minesweeper Fuchs. *U-27 on the left of the picture was an early loss, sunk by British destroyers off Scotland.*



Below: Belonging to the best-known German submarine flotilla, the 7th (Stier), U-52 is a Type VIIB which survived until the war's last days. Larger than the 'A' variant, the 'B' lacks the odd hump aft, the after torpedo tubes having been relocated within the hull.



U-Boat Aces: Gunther Prien

Of all the arms of German military might, it was the U-boat service which most threatened British survival, and early successes indicated that the U-boat would force Britain into surrender. In those early days, certain commanders stood out, notably Prien, Kretschmer and Schepke.

At 01.16 on 14 October 1939 the British battleship HMS *Royal Oak* was torpedoed whilst in the protected fleet anchorage of Scapa Flow. Within 15 minutes the veteran of Jutland had gone down in only 13 fathoms but taking with her 833 of her crew. An outstanding coup, the sinking marked the highpoint of the brief career of Gunther Prien; commander of the *U.47*.

Prien was very much a product of the despair that was the lot of the Germany of the 1920s. At this time he was a youth living in Leipzig with his mother, who eked out a meagre living by selling lace and the odd picture that she painted. Though living far from the sea, he thought of little else; there was, in any case, scant hope of employment in his home town. With his savings earned as a guide at the annual trade fair, he paid to go to the Seaman's College at Finkenwerder to start studies for the master's certificate of which he dreamt. Following initial training, he signed on in a square rigger as a 'Moses', or ship's boy, making a round voyage to the Gulf of Mexico only to be wrecked outside Dublin. Though arriving back in Hamburg a survivor, he discovered that he was in debt to the company to the tune of 5.70 marks for 'slops' received!

Going into steam, he stayed in the American trades and succeeded in becoming a fourth officer at the age of 21. Disillusion came only three years later when he passed for master but, instead of a ship's bridge, he found only the queue at the assistance board. The humiliation and frustration of useless unemployment, living on handouts of a few marks per week, made him join the National Socialists. Like so many of his generation, he saw in them the only force capable of restoring Germany to purpose and position.

Qualifying for command

After a spell in the voluntary labour corps, he joined the renascent Kriegsmarine, entering the U-boat training school in Kiel early in 1933. It took him little more than five years to qualify for command and he was rewarded with the U-47, a type VIIB boat being completed by the Germaniawerft in Kiel. She was commissioned into the 7th Submarine Flotilla whose distinguish mark, or *Wappen*, painted on the side of each conning tower, was a laughing bull.

With war a certainty, the German naval staff sailed 14 U-boats to North Atlantic stations in mid-August 1939; five, including Prien's boat, were from the 7th Flotilla. The war was only two days old when he accounted for his first British merchantman, the *Bosnia*; by his recall two days later he had added two more. He was already 8,000 gross registered tons toward the record he sought.

It was at the beginning of October that this promising commander was summoned to a conference at which was outlined an audacious plan to penetrate the British naval anchorage at Scapa Flow. Dönitz himself had worked it out and, asked his opinion, Prien thought the scheme feasible. He was promptly given the assignment, sailing on 8 October. In appalling weather he took until 13 October to reach the Orkneys, spending the day laying quietly on the bottom. After darkness had fallen, Prien surfaced to find calm conditions with a slight swell. Despite the lack of moon, however, the veil of the night was shot unpredictably with the multi-coloured shifting curtains of the Northern Lights. While these would assist him in his imminent problem of forcing an entry to the Flow they could also betray him to watchful eyes. Fortunately, for Prien, there were neither eyes nor radar.

Scapa Flow was, indeed, a poor abandoned sort of place compared with its heyday 20 years before, when it had harboured most of the Grand Fleet. Its defences were run down, and pre-war plans to upgrade them were as yet unexecuted. So poor were the defences that the Home Fleet had been long billeted on Loch Ewe, and few ships were now to be seen. The Flow itself is a wild, bleak water about 9.7 km (6 miles) across, surrounded by the treeless hills of the Orkneys. Access to it is by a dozen navigable channels, subject to fierce tidal flows and, for the most part at that time, boomed and defensively mined or obstructed by blockships. Dönitz had reasoned correctly that the movable obstructions were more likely to be patrolled than the fixed blockages which is why, shortly before midnight on 13 October,

U-boats seldom attacked their targets from under water, preferring to remain surfaced for an attack. Indeed, Prien and his U-47 torpedoed HMS Royal Oak *on the surface of Scapa Flow, escaping in the same manner.*

Prien was approaching the 700-m (765-yard) wide narrows between the islet of Lamb Holm and Mainland on the Flow's eastern side.

Aerial reconnaissance had suggested that this channel, though encumbered by a boom and four rotting blockships, could be negotiated at high water, though only experiment could tell. The submarine shouldered her way through, scraping both beach and barrier. Boldness paid off and, running free, the *U-47* found the net barrier beyond of small consequence. With diesels murmuring from the open hatch behind them, the bridge watch stared into the shifting gloom of the wide Flow that was opening up ahead. Initially, there was nothing to be made out then, to starboard, close under the hills of Mainland, could be seen the massive tophamper of a battleship. Beyond her was another. Prien identified them as HMS *Repulse* and an 'R' class battleship, and swung *U-47* around to close.

Royal Oak kill

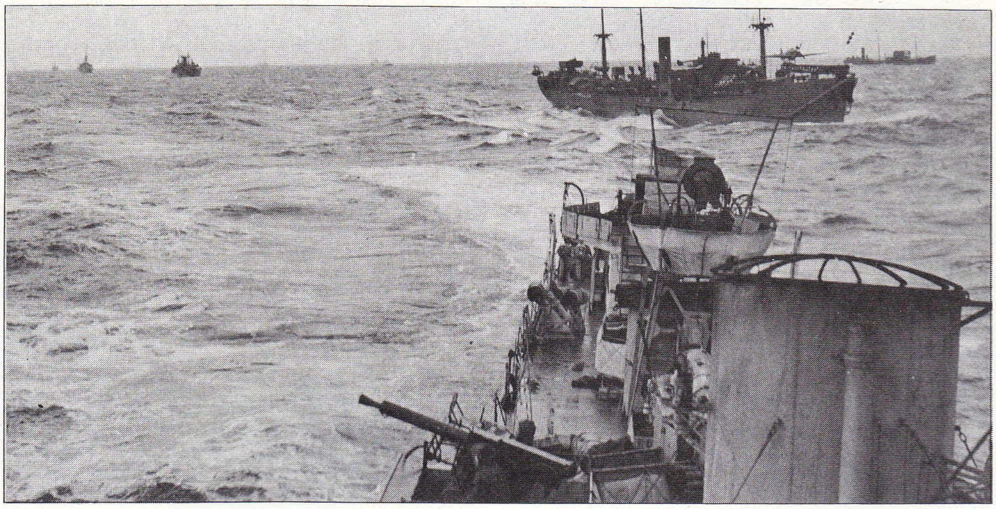
In fact, the ships were the *Royal Oak* lying outside the old seaplane carrier *Pegasus*.

The battleship belonged to the 2nd Battle Squadron, which had just completed an abortive search for the marauding German battlecruiser *Gneisenau*. Where the remainder of the force had returned to Loch Ewe, however, the *Royal Oak* and her escort, which had been covering the neighbouring Fair Isle Channel, had berthed at Scapa.

Remaining on the surface, Prien closed to 4000 m (4,375 yards) and, at 00.58, fired three torpedoes. At this time, German torpedoes were prone to both depth-keeping and magnetic pistol problems, and all that rewarded Prien'sefforts was a muffled detonation of no great intensity. Aboard the target herself, opinion differed as to whether it had been an air attack or an internal explosion. In all probability the anchor cable had been hit.

Prien calmly reversed his boat and loosed his single stern tube. Again no result and, incredibly, no apparent alarm. Labouring mightily the crew reloaded and a further salvo of three was unleashed. Only two hit, but it was more than enough, the old ship flooding rapidly. In 13 minutes her remains joined those of the German High Seas Fleet just 8 km (5 miles) to the west.

With the Flow now alive with small craft, Prien blasted back the way that he had come, just able to keep steerage way in the roaring tide under Lamb Holm. Less some more paintwork, he was in open water again by 02.15. Returning the 'hero of Scapa Flow', he was received by the Führer himself and awarded the Knight's Cross of the Iron Cross.



Given the combination of the small size of a conning tower, bad North Atlantic weather, nightfall and a paucity of escorts, it is no wonder that the U-boats could slip into convoys such as this with relative ease.

Though the *Royal Oak* was an old ship of limited value, her loss was a severe blow and led directly to others. With Scapa clearly vulnerable, the Home Fleet needed to use other anchorages, a point not lost on the Germans who used submarines to mine them. Thus

The return of Prien and his U-47 to harbour meant celebrations following the sinking of HMS Royal Oak. *The celebrations were appropriate, with Prien receiving the* Ritterkreuz *(Knight's Cross of the Iron Cross) personally from the Führer.*

U-31's mines at Loch Ewe were to damage the battleship HMS *Nelson* heavily and sink two minesweepers, while *U-21*'s mines in the Firth of Forth broke the back of the cruiser HMS *Belfast* and sank two other ships.

Faulty torpedoes were to dog Prien in the Norwegian campaign from April 1940, during which he missed a cruiser and transports at anchor, plus the battleship HMS *Warspite*. In the June, the so-called 'Group Prien' was formed with U-47 and six others. The group operated successfully in the Western Approaches, accounting for 32 merchantmen of about 175,000 gross registered tons, of which the leader's personal contribution amounted to eight ships of about 51,000 gross registered tons. This total included the ironic and controversial sinking of the ex-cruise liner *Arandora Star*, whose heavy passenger list comprised mainly Axis nationals en route to internment in Canada.

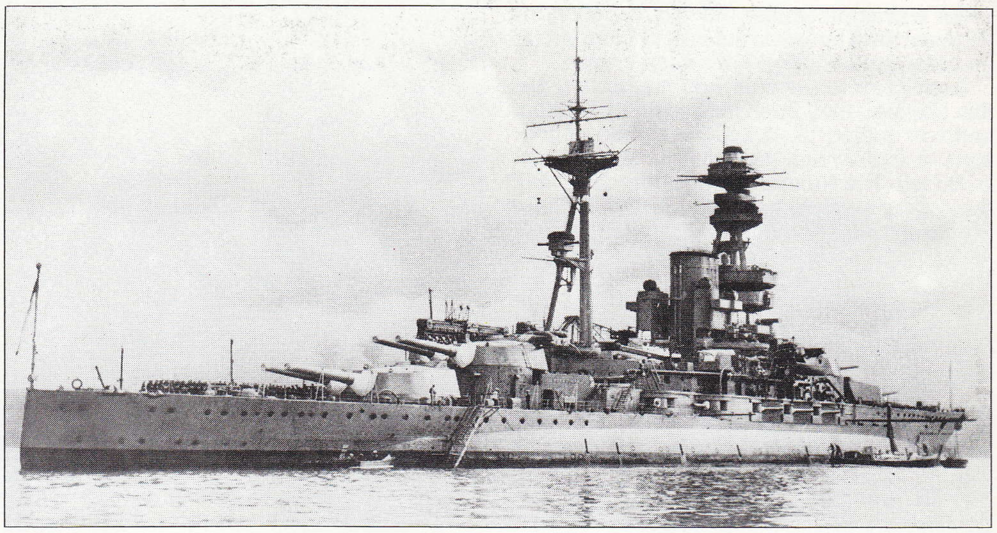
Using the effective tactic of entering a convoy on the surface at night, possible until the general fitting of radar to escorts, Prien sank four out of the five ships lost by the Halifax–UK convoy SC 2 in August 1940. In the October, he sighted HX 79, vectored in five other U-boats and mounted a co-ordinated onslaught that accounted for 14 ships, three to Prien.

Last action

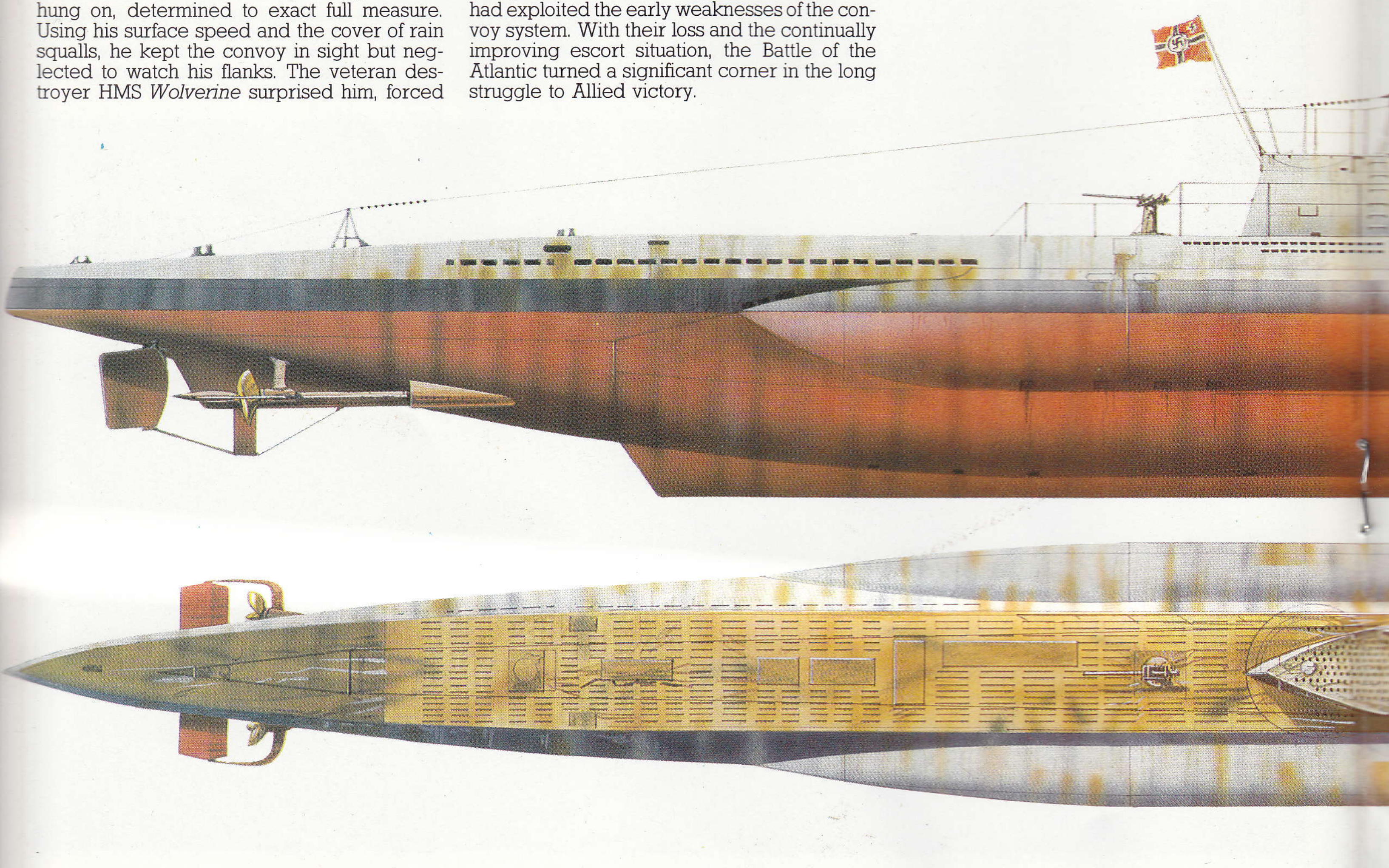
On 6 March 1941 Prien located the westbound OB 293 and brought in four other boats. The convoy was stoutly defended, losing four ships at an initial cost to the Germans of one U-boat sunk and one severely damaged. Prien hung on, determined to exact full measure. Using his surface speed and the cover of rain squalls, he kept the convoy in sight but neglected to watch his flanks. The veteran destroyer HMS *Wolverine* surprised him, forced him down and sank him with all hands. It was dawn on 8 March 1941.

Beside the *Royal Oak*, Gunther Prien's personal score included 30 merchantships of about 165,000 gross registered tons. His loss was admitted by the German high command a fortnight later, together with the posthumous award of the Oak Leaves to his Knight's Cross.

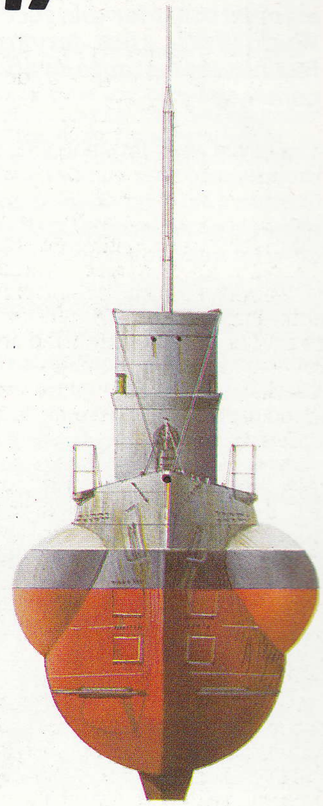
Strangely, after three months when not a single U-boat had been sunk, the Germans lost four in March 1941. Two of the others also were commanded by 'aces', Kretschmer's *U-99* and Schepke's *U-100*. Able skippers such as these had exploited the early weaknesses of the convoy system. With their loss and the continually improving escort situation, the Battle of the Atlantic turned a significant corner in the long struggle to Allied victory.



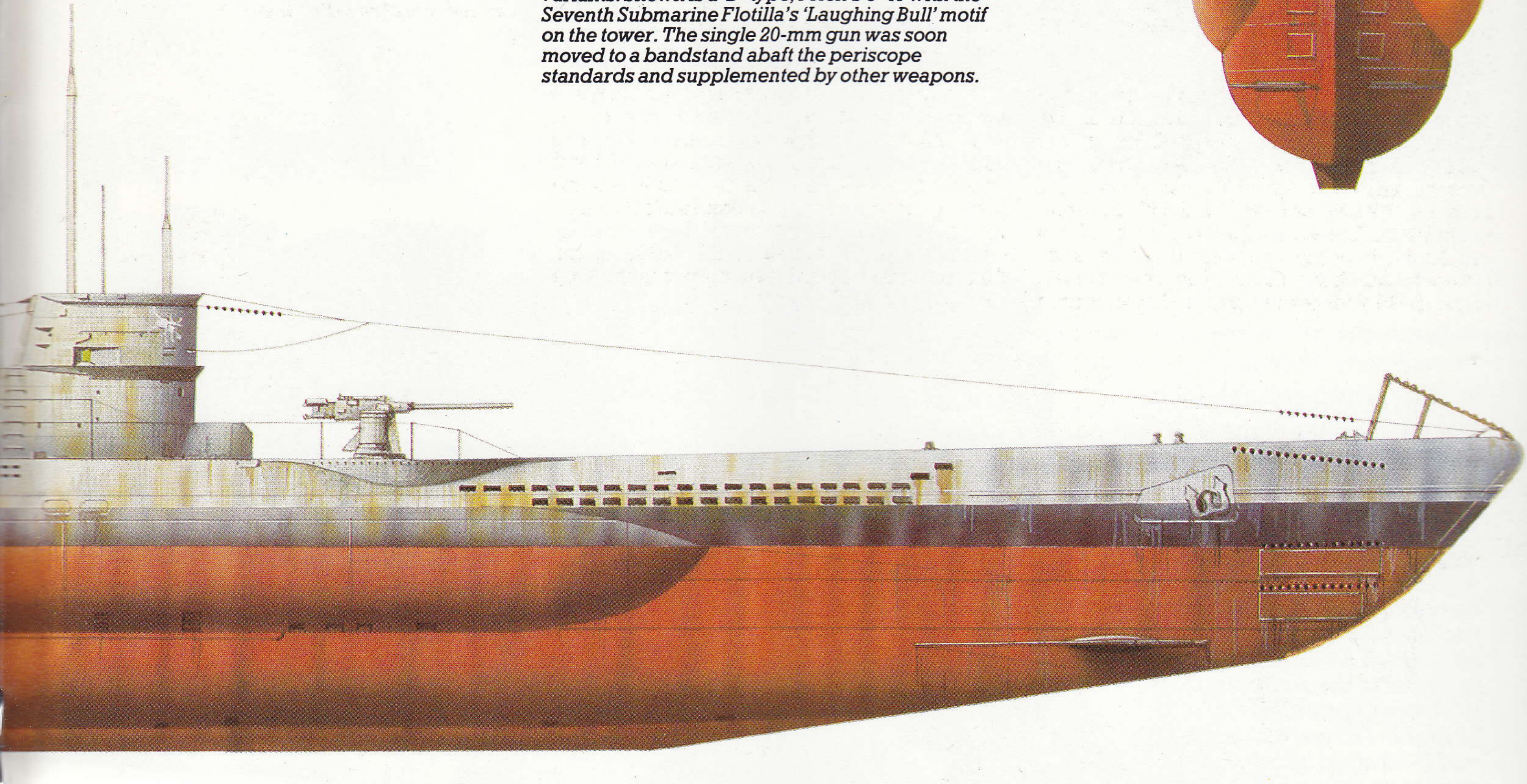
***Above:** HMS* **Royal Oak** *was a veteran of World War I, an 'R' class battleship partially modernized between the wars. Not as effective as the contemporary 'Queen Elizabeth' class, nevertheless her loss in the waters of Scapa Flow was a severe blow to British pride.*

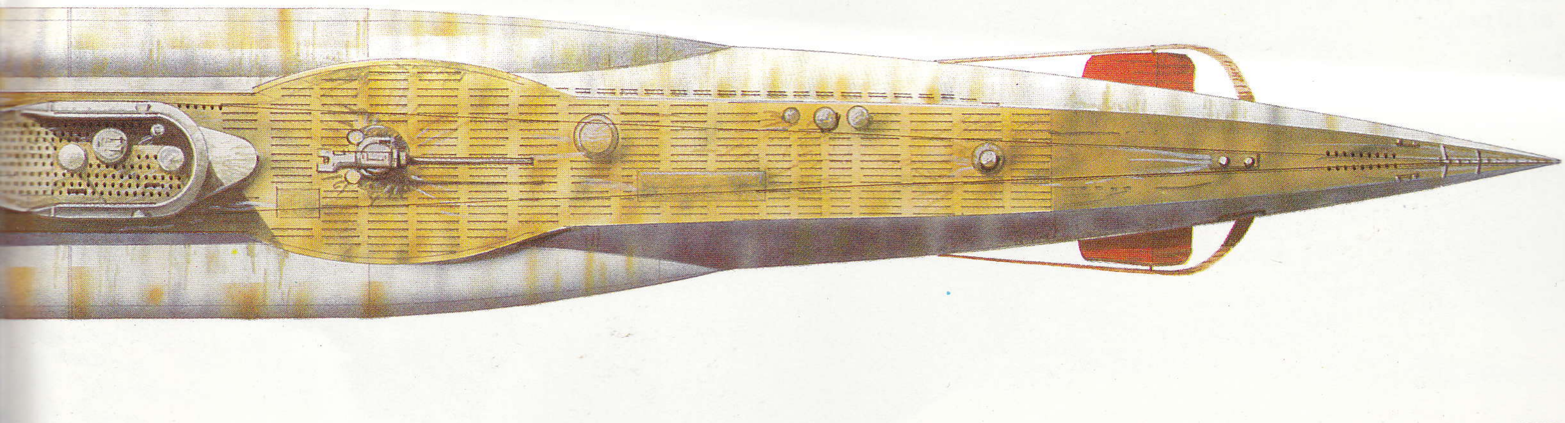


Type V11B *Unterseeboot U-47*



Below and right: Workhorse of the German submarine fleet, the Type VII appeared in six main variants. Shown is a 'B'-type, Prien's U-47 with the Seventh Submarine Flotilla's 'Laughing Bull' motif on the tower. The single 20-mm gun was soon moved to a bandstand abaft the periscope standards and supplemented by other weapons.





U-Boat Aces: Otto Kretschmer

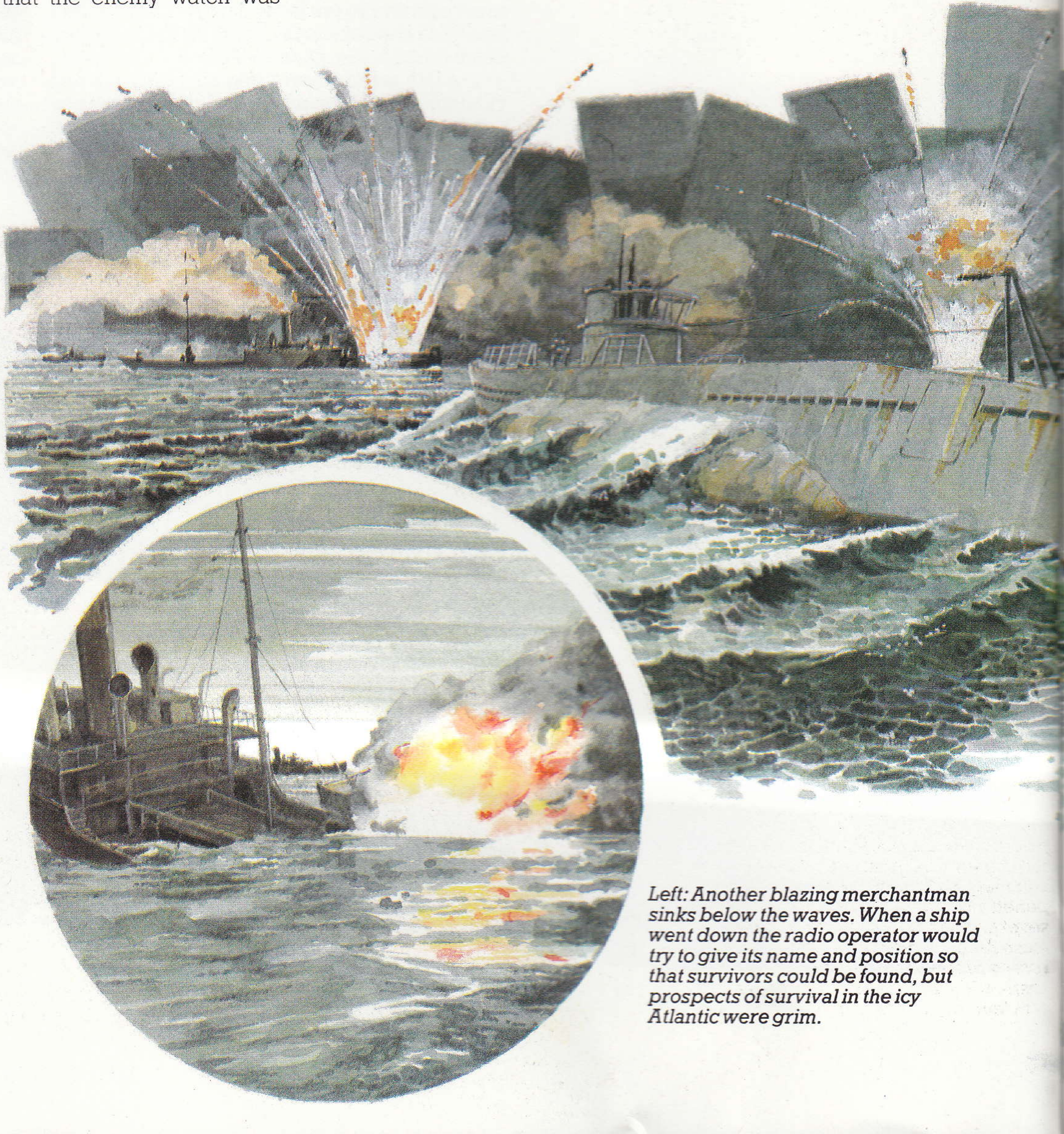
During World War I some U-boat commanders had experimented with night attacks on the surface, and had enjoyed considerable success. In the first 18 months of World War II, a few daring captains developed night-fighting techniques that cut a swathe through Britain's Atlantic convoys.

The havoc wrought among the convoys by the U-boat aces was out of all proportion to their number: in the infamous assault on convoy SC 7 on 18 October 1940, Otto Kretschmer's *U-99* inflicted more casualties than the other seven submarines that took part in the battle, the captain and his crew returning to a hero's welcome at their base at Lorient. This attack, a classic success for Admiral Dönitz and his U-boat commanders, originated when *U-93* made a general signal giving the position, course and speed of a large convoy it had spotted. In accordance with U-boat tactical doctrine, *U-93* endeavoured to shadow the convoy while all other U-boats within range converged on the area. The convoy managed to shake off *U-93*, only to be spotted by *U-48* on the afternoon of 17 October; but by intercepting signal traffic the British knew SC 7 was being followed and the convoy made several violent course alterations, and *U-48* lost contact too. Dönitz promptly ordered his U-boats to deploy into an 'interception stripe' across the probable course of the convoy. SC 7 eventually brushed the northern edge of the line, and as darkness fell the wolfpack pounced: 17 ships were sunk in a night of desperate fighting.

The aces ignored the procedures they had learned before the war and instead closed to attack on the surface. Kretschmer's favourite attacking position was from the dark side of a convoy so that the target ships were silhouetted against the moon, but if the night was too dark then he approached from windward so that the enemy watch was squinting against the wind and spray.

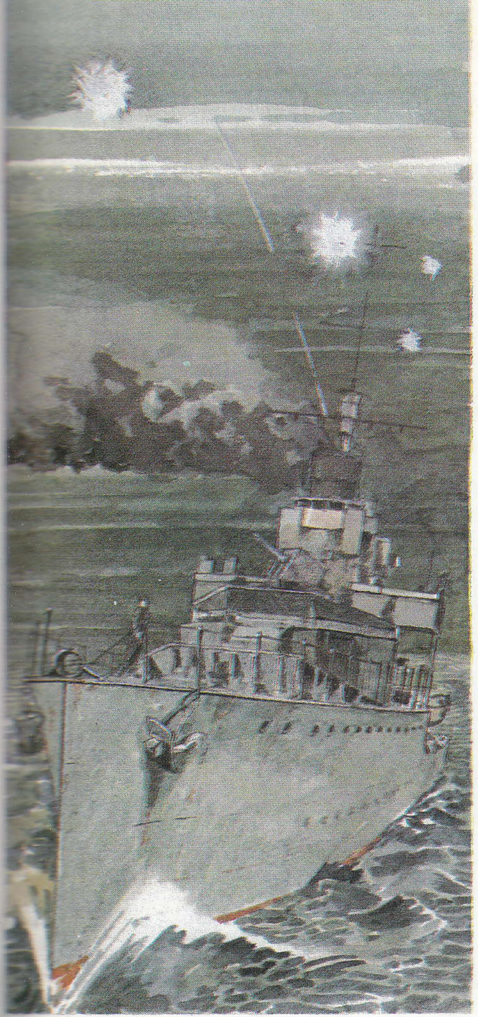
While many U-boats still made orthodox submerged attacks from outside the escort screen, *U-99* weaved among the columns of hapless merchantmen, sending ship after ship to the bottom. Kretschmer commanded that only he could order a crash dive, being firmly convinced that safety lay on the surface. However imprecise, Asdic could pinpoint submerged U-boats for a potentially lethal depth-charging. Time and time again, Kretschmer evaded escorts with his high surface speed, quite prepared to fight his way out rather than submerge. The eventual fate of *U-99* was to prove him right.

On 16 March 1941, *U-99* joined in another wolfpack attack, slipping past the escorts at dusk and sinking four tankers and two freighters by 3 am. It was her fourth battle in as many weeks, and signalled the end of the patrol. Low on fuel, she set course for home, her captain going below to compose his report to Lorient. But the watch was not alert, and when two destroyers suddenly loomed out of the darkness a junior officer panicked and ordered a crash dive. Kretschmer's worst fears were then realized as *U-99* was located by Asdic and pounded with depth charges. Her lights went out and she plunged out of control well below the maximum safe depth. Ankle deep in water and with the hull groaning under the pressure, Kretschmer had no choice but to surface and surrender.



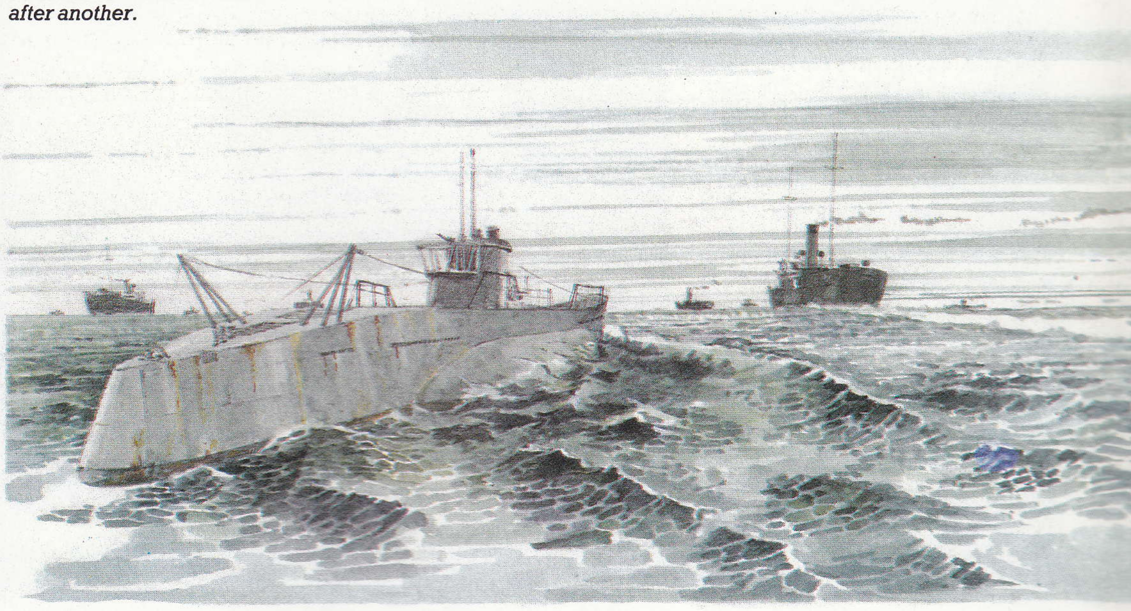
The attack on convoy SC 7 took place on the night of 18 October 1940: six U-boats, including Kretschmer's U-99 and Schepke's U-100, attacked at dusk. Kretschmer manoeuvred U-99 to aim at a ship on the edge of the convoy when the target suddenly exploded, torpedoed by another member of the wolfpack. A destroyer appeared just as U-99 and U-123 were closing in, and U-99 sped off into the darkness, returning to attack at 10 pm.

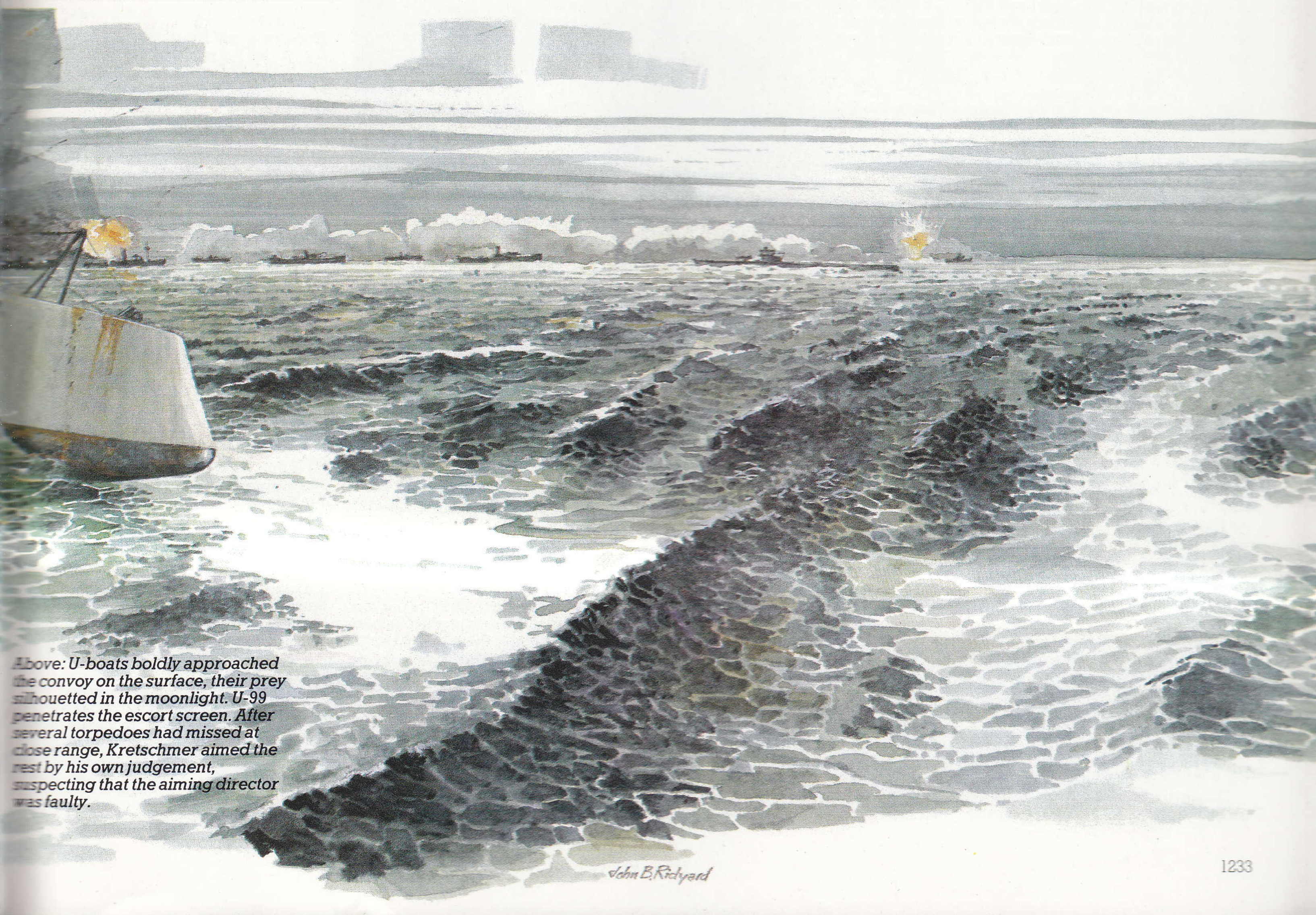
Left: Another blazing merchantman sinks below the waves. When a ship went down the radio operator would try to give its name and position so that survivors could be found, but prospects of survival in the icy Atlantic were grim.



Left: The escorts frantically fire starshell bursts to locate the German submarines. Once spotted, a U-boat could be depth-charged or even attacked by the most ancient naval weapon of all, the ram. Schepke was eventually to perish this way, cut in half with his U-boat, but this night the escorts had no such luck and merchantmen went down one after another.

Below: As the attack draws to a close, U-99 works her way round to the rear of the convoy with the intention of expending her last torpedoes on a straggler. Kretschmer and his crew had sunk nine ships out of the 17 lost by SC 7, and returned to base at Lorient four days later to a hero's welcome.





Above: U-boats boldly approached the convoy on the surface, their prey silhouetted in the moonlight. U-99 penetrates the escort screen. After several torpedoes had missed at close range, Kretschmer aimed the rest by his own judgement, suspecting that the aiming director was faulty.

GERMANY

Type IX

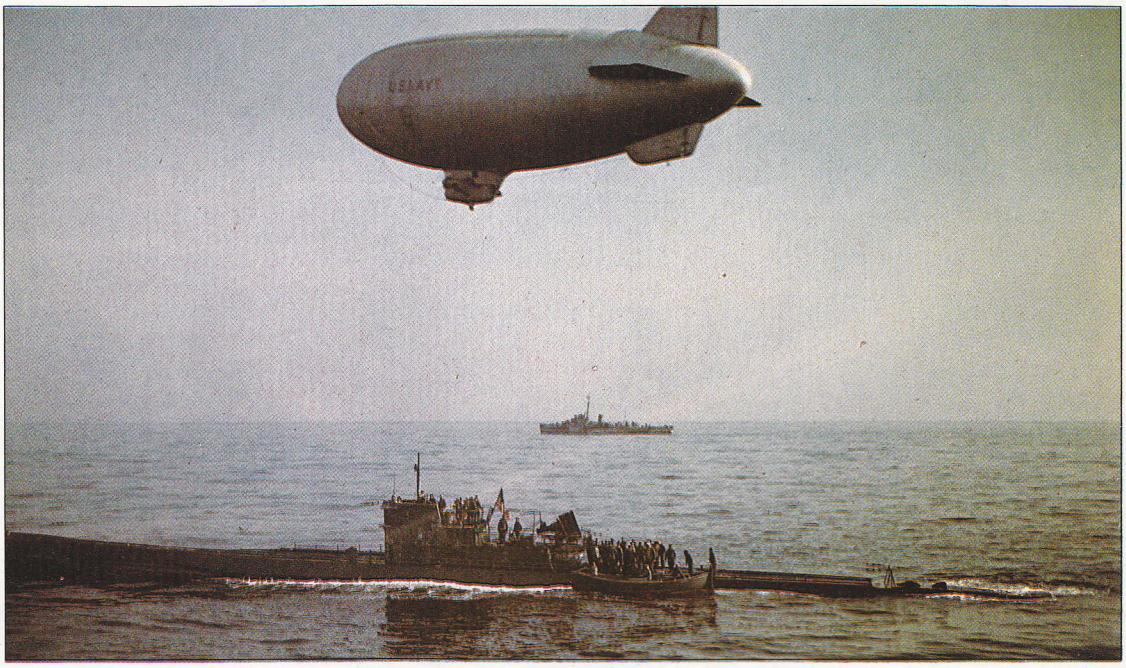
The **Type IX** class was designed for ocean warfare. Loosely based on the far smaller **Type II**, it differed fundamentally in having a double hull. This feature increased useful internal volume by enabling fuel and ballast tanks to be sited externally. In turn, the extra hull improved survivability by cushioning the inner (pressure) hull from explosive shock and gave the boats greatly improved seakindliness on the surface. Habitability was improved for operations of longer duration and the number of torpedoes carried, at 22, was about 50 per cent more than those of a Type VIIC. The deck gun was increased in calibre from 88 to 105 mm (3.465 to 4.13 in).

To give an idea of how designs developed during the course of the war, the **Type IXA** and Type VIIA variants were, respectively, 76.5 and 64.5 m (251 and 211.6 ft) long, while the final **Type IXD** and Type VIIF marks, were 87.5 and 77.6 m (287.07 and 254.6 ft) long.

The major objective with the Type IX variants was to improve range rather than offensive capability. Thus the eight Type IXA boats could achieve 19500 km (12,120 miles) on the surface at 10 kts yet, even before September 1939, were being complemented by the first of 14 **Type IXB** boats capable of 22250 km (13,825 miles). These were followed by the largest group, the **Type IXC** and slightly modified **Type IXC-40**, 149 boats with bunkers for 25000 km (15,535 miles).

From the opening of hostilities, the Type IXs worked the western and southern Atlantic and, on the entry into the war of the United States, were supplemented by Type VIICs for the 'Happy Time', ravaging shipping down the USA's eastern seaboard to the Caribbean before a proper convoy system had been instituted.

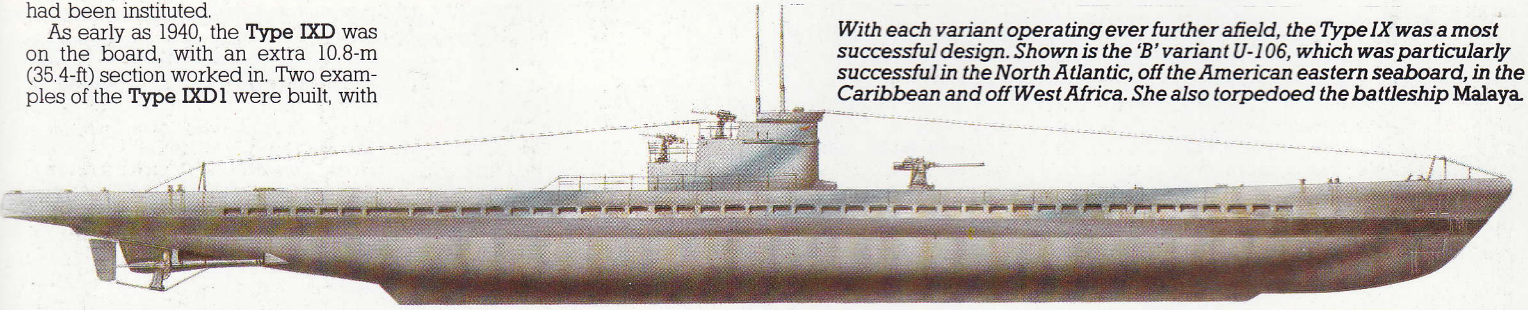
As early as 1940, the **Type IXD** was on the board, with an extra 10.8-m (35.4-ft) section worked in. Two examples of the **Type IXD1** were built, with no armament, but capable of stowing over 250 tons of fuel for the topping-up of other boats. The 29 **Type IXD2s** boats were operational boats with the phenomenal range of 58400 km (36,290 miles), enabling them to work the Indian Ocean and even reach Japan. Some included a small, single-seat towed gyro-kite to increase their visual search radius. The Type IXD2 was further refined to the **Type IXD2-42**, but only one of this variant was ever completed. Advanced diesels in the Type IXD1s gave a 21-kt surface speed, but were found unreliable and not repeated.



Already wearing the 'Old Glory', a surrendered Type IX U-boat wallows in a quiet sea off the American coast, in May 1945, watched by a DE and a blimp. This example was a 'D' variant, longer than earlier versions.

Specification
Type IXC
Type: ocean-going submarine
Displacement: 1,120 tons surfaced and 1,232 tons submerged
Dimensions: length 76.70 m (251 ft 8 in); beam 6.75 m (22 ft 2 in); draught 4.70 m (15 ft 5 in)
Propulsion: surfaced diesels delivering 4,400 hp (3281 kW) and submerged electric motors delivering 1,000 hp (746 kW) to two shafts
Speed: surfaced 18.2 kts and submerged 7.5 kts
Range: surfaced 25000 km (15,535 miles) at 10 kts and submerged 115 km (71.5 miles) at 4 kts
Armament: one 105-mm (4.13-in) gun, one 37-mm AA gun, one 20-mm AA gun, and six 533-mm (21-in) torpedo tubes (four forward and two aft) with 22 torpedoes
Complement: 48

With each variant operating ever further afield, the Type IX was a most successful design. Shown is the 'B' variant U-106, which was particularly successful in the North Atlantic, off the American eastern seaboard, in the Caribbean and off West Africa. She also torpedoed the battleship Malaya.



GERMANY

Type X and Type XI

Of the five main types of U-boat identified by pre-war staff requirements, the patrol submarines of short-, medium- and long-endurance capabilities became the Type II, Type VII and Type IX respectively. The others were a 'small' minelayer and a long-range cruiser submarine; with modifications, these became the **Type X** and **Type XI**.

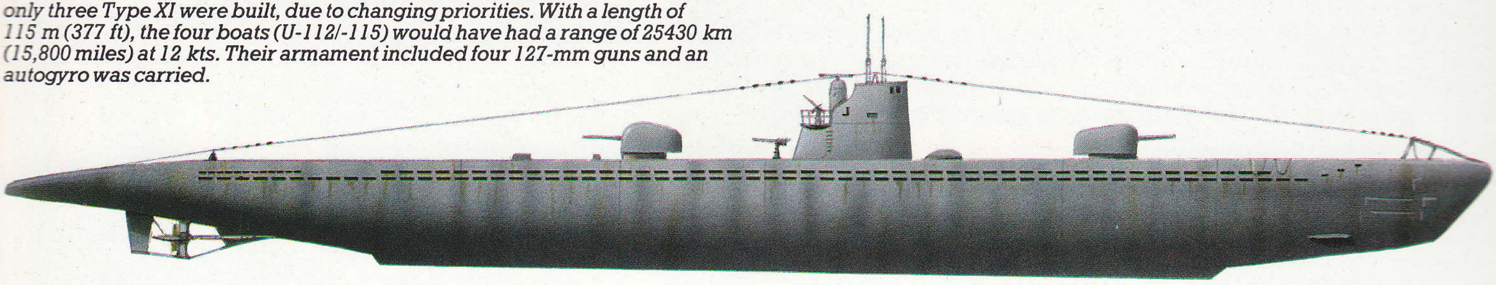
Only three type XIs were ever built, these being very large boats with a length of 115 m (377.3 ft) and a surface displacement of 3140 tons. Essentially submersible surface raiders, they had a useful surface speed of 23 kts, and a superstructure that included stowage for a small scout seaplane and paired 127-mm (5-in) guns at each end.

Though the large cruiser submarine had enjoyed some success during World War I, its mode of operation rapidly became impossible in World War II and the type was discontinued. Indeed, the boats' most noteworthy achievement seems to have been *U-601*'s initial sighting of the British convoy JW 55B in the Norwegian Sea on Christmas Day 1943. Her contact report was responsible for the sailing of the *Scharnhorst*, bent on interception. She, in turn, was met by the Royal Navy and sunk the following day.

The **Type XA** was, in fact, a very large minelayer design, a 2,500-tonner incorporating multiple vertical mine-stowage shafts of the type used successfully in the Type VIIDs. Possibly considered vulnerable because of its size, the Type XA never progressed beyond the drawing board, being superseded by the **Type XB**. These eight boats were smaller, with a circular-section pressure hull flanked by a slab-sided outer hull of generous proportions. On the centre-line forward, six mine storages projected from keel to the top of a hump in the casing, each accommodating three mine assemblies. On each side, in the space between the hulls, were fitted 12 shorter stowages, each containing two mines. The total load was, therefore, 66 large mines. Built to avoid action as far as possible, the type XBs had only two torpedo tubes, squeezed in right aft. They proved to be better employed in resupply rather than minelaying.

Specification
Type XB
Type: minelaying submarine
Displacement: 1,763 tons surfaced and 2,177 tons submerged
Dimensions: length 89.80 m (294 ft 7 in); beam 9.20 m (30 ft 2 in); draught 4.11 m (13 ft 6 in)
Propulsion: surfaced diesels delivering 4,200 bhp (3131 kW) and submerged electric motors delivering 1,100 hp (820 kW) to two shafts
Speed: surfaced 16.5 kts and submerged 7 kts
Range: surfaced 34400 km (21,375 miles) at 10 kts and submerged 175 km 109 miles) at 4 kts
Armament: one 105-mm (4.13-in) gun (later removed), one 37-mm AA gun, one (later four) 20-mm AA guns, two 533-mm (21-in) torpedo tubes (both aft) with 15 torpedoes, and 66 mines
Complement: 52

Planned at a time when the larger cruiser submarine idea was still in vogue, only three Type XI were built, due to changing priorities. With a length of 115 m (377 ft), the four boats (U-112/-115) would have had a range of 25430 km (15,800 miles) at 12 kts. Their armament included four 127-mm guns and an autogyro was carried.



GERMANY

Type XVII

A combination of anti-submarine aircraft and radar gradually made it impossible for U-boats to use their high surface speed as a basis for attack and, to ensure their survival as a viable attack platform, submarines had to be optimized for submerged performance. Only a machinery system independent of surface air in combination with a cleaned-up, high-speed hull would suffice, and the **Type XVII** marked this fundamental and transitional step forward.

The key to the concept was the Walter closed-cycle propulsion system that relied on the near-explosive decomposition of concentrated hydrogen peroxide in the presence of a catalyst. The reaction produced a high-temperature mix of steam and free oxygen into which fuel oil was injected and fired, resulting in high-pressure gases that were made to drive a conventional turbine. A weakness of the principle was that almost any impurity could act as a catalyst to initiate the process at a disastrously early stage.

Two prototype boats proved the machinery feasible, and the system was pressed into service in the Type XVIIs. A drawback was the extreme thirst of the system, dictating a small boat with a single propeller. For cruise purposes, this was driven by a conventional diesel/electric combination, with the Walter coupled up only to force or decline an engagement.

Externally, the hull was cleaned-up, with no guns and a minimum of protuberances. It was of figure-eight section, formed of two overlapping circular pressure hulls of unequal diameter. In practice, the length to beam ratio was too high, resulting in an unnecessarily high drag. This meant that the **Type XVIIA** never realized its theoretical top speed of 25 kts possible with two turbines on a common shaft. So only four such boats were built, the modified **Type XVIIB** (three completed) having only one turbine. Space was available for only two torpedo tubes, with but one reload for each, a deficiency offset by the increasing lethality of the weapon.

A projected **Type XVIIK** would have abandoned the volatile Walter for conventional diesels aspirated with pure oxygen stored aboard.

Specification

Type XVIIB

Type: coastal submarine

Displacement: 312 tons surfaced and 357 tons submerged

Dimensions: length 41.50 m (136 ft 2 in); beam 3.40 m (11 ft 2 in); draught 4.25 m (14 ft 0 in)

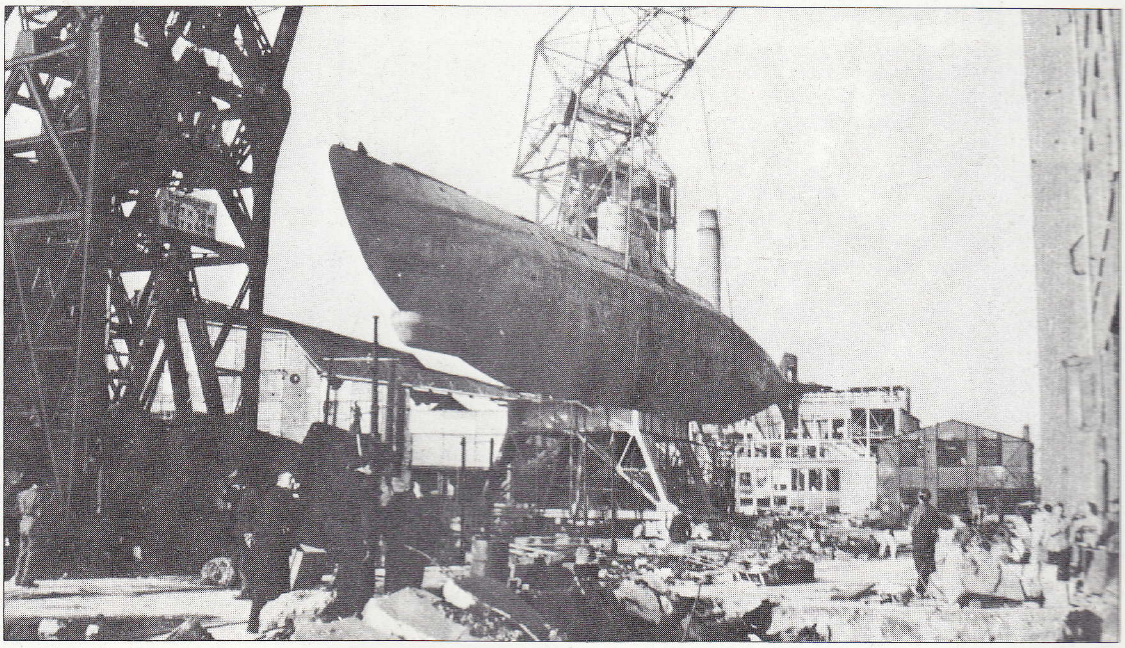
Propulsion: surfaced diesel delivering 210 bhp (157 kW) and submerged Walter closed-cycle engine delivering 2,500 hp (1865 kW) or electric motor delivering 77 hp (57 kW) to one shaft

Speed: surfaced 9 kts and submerged 21.5 kts on Walter engine or 5 kts on electric motor

Range: surfaced 5550 km (3,450 miles) at 9 kts and submerged 210 km (130.5 miles) on Walter engine or 75 km (46.6 miles) on electric motor

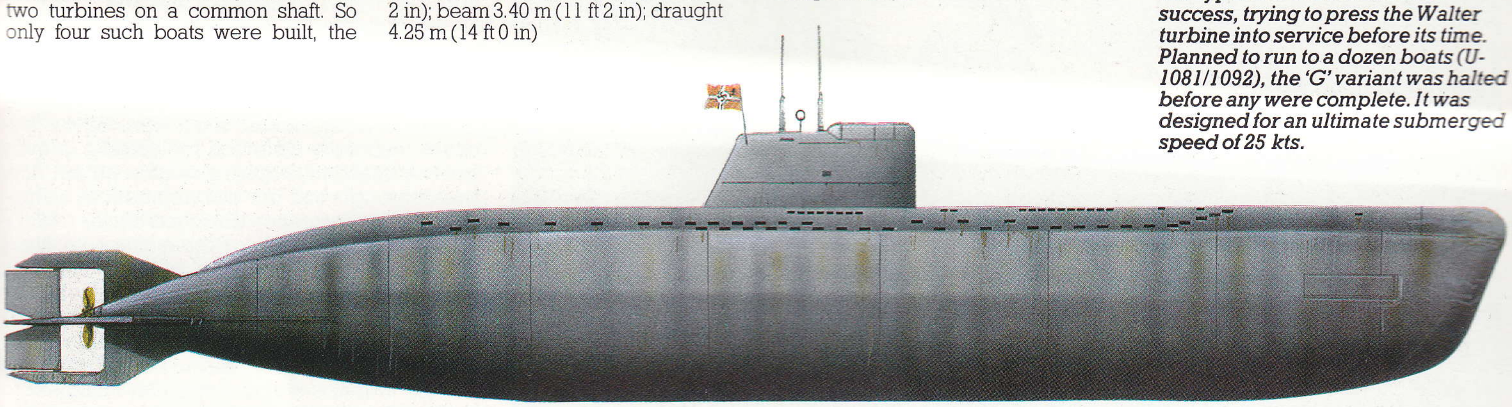
Armament: two 533-mm (21-in) torpedo tubes (both forward) with four torpedoes

Complement: 19



One of the nearly complete Type XVII Walter turbine boats is transferred by a 350-ton floating crane through the shattered Kiel yard of Howaldtswerke. Advanced features include a hydrodynamically clean hull and a single propeller set in cruciform control surfaces. Note the sonar dome forward.

Few in numbers but rich in variants, the Type XVII U-boat was not a success, trying to press the Walter turbine into service before its time. Planned to run to a dozen boats (U-1081/1092), the 'G' variant was halted before any were complete. It was designed for an ultimate submerged speed of 25 kts.



Science versus the U-Boat

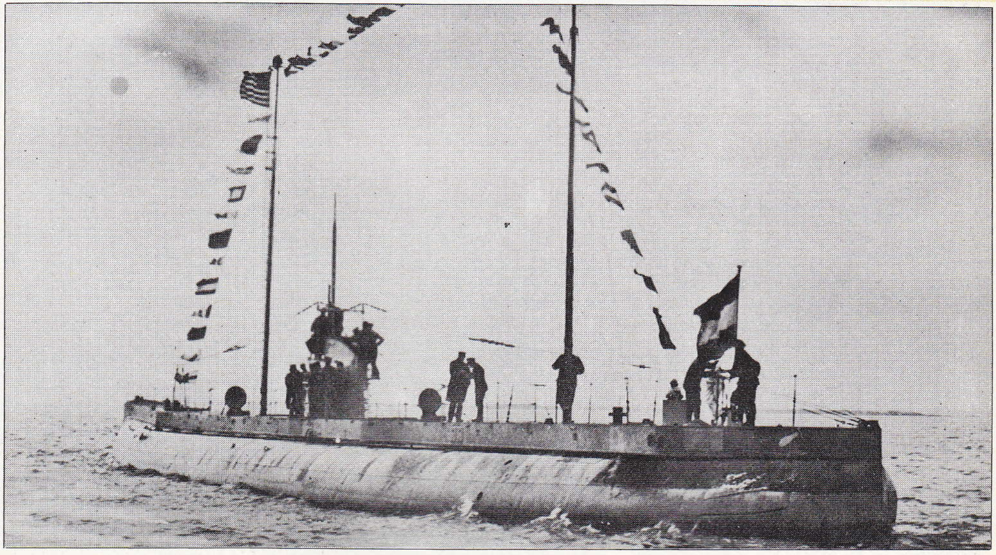
Warfare has always been a forcing-ground for technological change, but no war has been more dependent upon science than the struggle between the submarine and the escort vessel. Swinging first one way and then the other, the Battle of the Atlantic was to be won by the side with the technological edge.

The UK's near total dependence upon seaborne commerce has proved a weakness often exploited by her enemies. During World War I the Germans were able to keep their High Seas Fleet as a threat 'in being' while using their submarines almost without restriction to damage the British economy, to the extent that victory was lost only through the rediscovered art of convoy.

Hitler, with an even weaker surface fleet, looked again in 1939 to his U-boats to blockade the British into submission. The courage of the submarine crews was, however, to be matched by that of the British and their allies, backed by technology that was eventually to prove decisive.

Science could assist, not only in developing the familiar 'black boxes' but also in passive assessment of the struggle to come. A convoy system was obviously required but, bearing in mind the enemy's weaknesses and strengths, answers to fundamental questions were also required. What was the optimum convoy size and how best was it to be arranged? How many escorts were needed and where were they to be placed? In terms of cargo ship/days, was it more effective to run 'independents', with their higher loss rates, than to keep ships hanging around waiting for a convoy? What routes and convoy cycles best served the war effort, while taking into account the limited escort capacity? The science of operational research provided the answers to these questions and many more.

The basic weakness of the U-boat was its slow speed and endurance once submerged. Even surfaced, its horizon was normally limited to about 16 km (10 miles), and it could be simply demonstrated that a single group of ships was far less likely to be detected than a number of independents. Also, to devote warships to convoy escort duties was not totally defensive warfare for, once sighted, the convoy acted as the bait to bring the U-boat to the hunter, saving much fruitless search. Only by directly patrolling the submarines' transit routes could anti-submarine ships be employed as effectively.



In an attempt to extend the endurance of the U-boats, special resupply submarines were developed, to enable regular attacks on sea routes far from the increasingly well protected convoys. As these 'milchcows' were sunk, the U-boats turned their attentions back to the main target, the convoys.

Independents suffered losses at two to three times the rate of ships in convoy, but the Admiralty's belief that the latter should not exceed 40 ships came under scrutiny. Escorts were allocated (ideally, at least) at three to a very small convoy, plus one for each additional 10 ships. This principle was shown to be anomalous for, applying it, say, to two separate convoys, each of 20 ships, each would need to be accompanied by five escorts, yet by combining the two convoys into one of 40 ships, only seven escorts would be required.

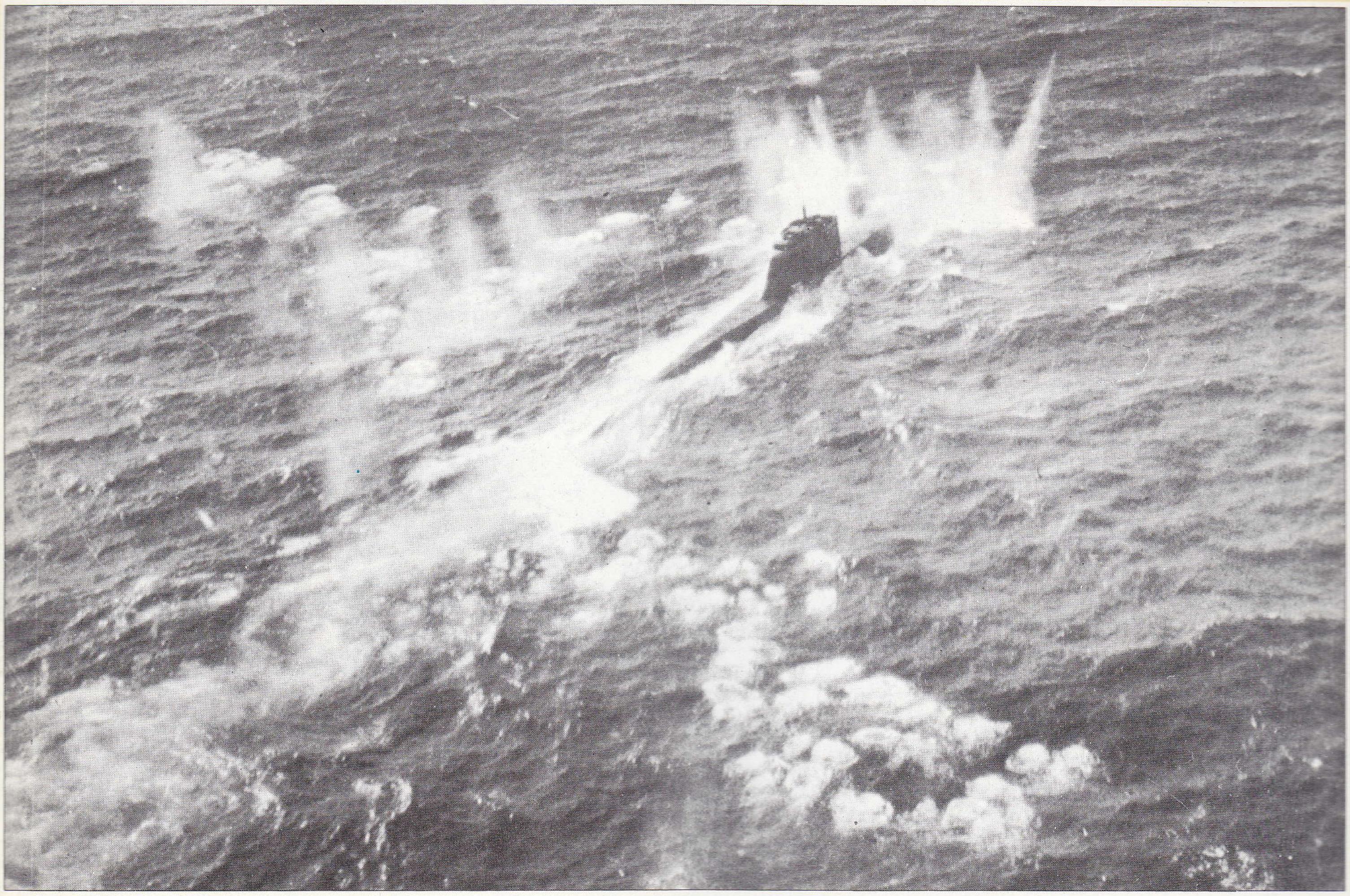
With escorts in desperately short supply, the reasoning was attractive. It was also correct, for though twice as many ships occupied twice the area, their perimeter (assumed circular) increased by less than 50 per cent. To extrapolate further, 60 ships had less than twice the perimeter of 20 and 100 less than 2½ times. Thus to keep the same spacing, all else being equal, only 12 or 13 escorts were required for a 100-ship convoy, where 25 would have been needed for five 20-ship convoys, together with a higher risk of detection. Larger convoys were instituted in early 1943 and halved the loss rate.

Under whatever flag, surface watchkeeping on a submarine was wet and endless but vital to spot targets or for self-protection against aircraft when re-charging. These crewmen are Italian, on what appears to be an 'Adua' class boat.

Increased listening capacity

A surfaced submarine could extend its limited horizon by listening for a convoy's hydrophone effect or by sighting its smoke, but a group of submarines could increase its chance by forming a line of bearing across a suspected track. Should a submarine make a contact it would report to its shore-based control on HF, the latter rebroadcasting on MF to all boats to close in, the well known 'wolfpack' tactic (known to the Germans as *Rudel Taktik*). The weaknesses of the system were the amount of wireless traffic generated and the need for U-boats to run on the surface, failings both exploited by the British.

Rapid and encyphered, the transmissions tended to have a pattern and, even before they could be decyphered, they were useful because their very direction indicated a convoy under threat and requiring reinforcement. The breakthrough was the development of a shipborne high-frequency direction-finder (H/F D/F or 'Huff Duff'). Two or three ships so fitted could accompany a convoy and take bearings on any transmissions, which if close enough or on a bearing that posed a threat, would be aggressively run down by the best-positioned escort. To sink the submarine was a bonus but merely to make it submerge was sufficient to for it to lose touch, sometimes for good, as the



The advanced technology of the German Type XXI counted for little when caught on the surface by marauding aircraft. Extensive mining obliged them to transit coastal waters in groups and accompanied by minesweepers.

German boat's submerged performance at that time was poor.

U-boats were, indeed, surprised and sunk but, as H/F D/F appeared at about the same time as escort-borne radars, the latter tended to be suspected by the enemy as the cause.

Asdic (now termed 'sonar') was widely fitted in Royal Naval escorts, but its effectiveness had been rather overrated before the war, and this factor was compounded by the common practice by surfaced U-boats of attacking a convoy at night, capitalizing on their small silhouettes. The answer was radar, the escorts being fitted with modified metric-wavelength ASV sets from aircraft, these being gradually replaced by centimetric sets that could detect a surfaced submarine out to about 6.4 km (4 miles).

Aircraft sub-hunters

It was the aircraft that proved the greatest nuisance to the surfaced U-boat, but its presence with a convoy did have the drawback of necessitating a degree of radio traffic where, otherwise, silence was observed. Even with radar, aircraft took a while to develop the art of submarine hunting, partly because the Germans had a radio receiver that very effectively detected radar transmissions, enabling rapid avoiding action to be taken. Not until November 1941 was the first 'kill' ascribed to radar. By early 1943 shorter wavelengths confounded the German equipment and, for a space of three months, U-boat losses ran at an average of one per day.

Night-running on the surface, even to charge batteries, became prohibitively dangerous when aircraft received the 80-million candlepower Leigh Light, extra guns and improved depth charges with which to mount sudden and unannounced onslaughts from out of the darkness.

The enemy survived by developing the *Schnorckel* (snort) but slow, submerged transits now occupied most of a boat's endurance and even on station high surface speeds could not be used. Efficiency fell off rapidly. Desperately, some U-boats carried enhanced AA armament, electing to fight it out on the surface. This suited the aircraft very well, and spiralling U-boat losses soon discouraged the practice, with air-to-surface rockets proving particularly effective against the submarine's thick hulls.

With the U-boat now attacking submerged, Asdic came back into its own. In 1943, if she kept her speed down to about 15 kts, an escort could obtain a contact at up to about 2.4 km (1.5 miles) but, because of the geometry of the pencil beam, contact was lost on the run-in, some 275 m (300 yards) short of target. As charges were still dropped or fired over the target's position, this gave an alert submarine commander a precious half minute to take the evasive action. Ahead-firing weapons were therefore developed. Mousetrap and Hedgehog and, later, the Squid, were able to reach the target before contact was lost. The Squid, in fact, was soon used in conjunction with an Asdic that could measure depth as well as range and bearing.

Any U-boat seeking to attack a convoy was then forced to tackle the escorts first, particularly as aircraft were usually present. A favoured weapon was the Zaunkönig acoustic torpedo, tuned to home on the escort's fast-running propellers. After some losses, the tactice adopted was to locate the torpedo's approach on hydrophones and stop engines. The enemy responded with more delicate tuning to detect the noise of auxiliary machinery, defeated in turn by the escort towing an acoustic decoy known as 'Foxer'.

Forerunner of today's countermeasures, the Foxer was only one such item, American contributions included Magnetic Anomaly Detection (MAD) as early as 1942, with sonobuoys a year later. The British had an air-launched anti-submarine homing torpedo, FIDO, by mid-1943.

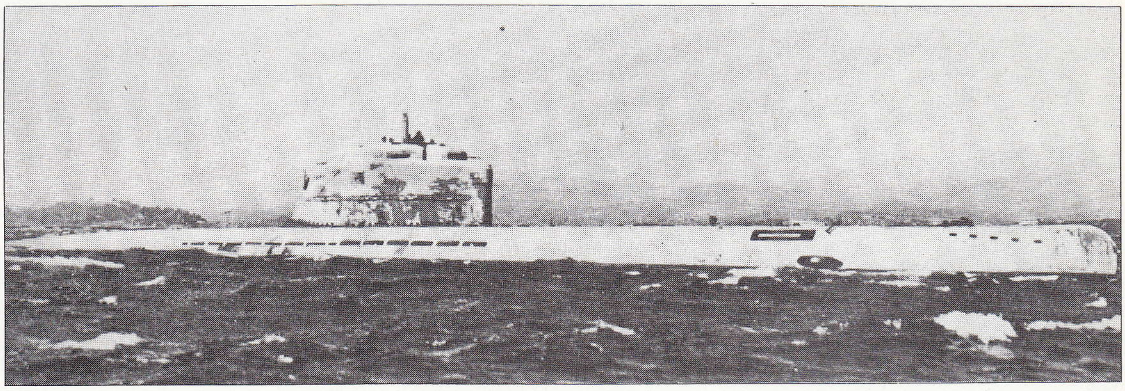
High-speed submarines

Ultimately the Germans introduced the high-speed submarine in the Types XXI and XXIII. The former had a 16-kt submerged speed, underwater fire control and advanced torpedoes but, fortunately for the Allies, was brought into service too late to have much impact.

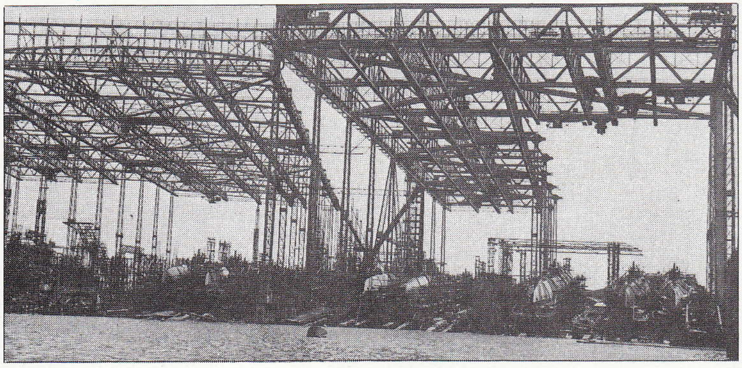
Through all causes, the Germans lost nearly 800 U-boats during the war. These had accounted for over 14 million gross registered tons of mercantile losses, over two-thirds the total from all causes. Science assisted the Allied victory immeasurably in both anticipating and responding to enemy developments.

GERMANY

Type XXI



Above: Lack of paint on both tower and stemhead are clues to the high speeds attained by this Type XXI. The hull is faired into an almost elliptical cross-section, leaving little deck, and the forward hydroplanes fold back into slots to reduce drag.



Left: The Blohm und Voss slips in May 1945 give an idea of the level to which series production of submarines had progressed. These Type XXI boats are being assembled from hull sections prefabricated at many inland sites and transported to Hamburg by water.

One of the most influential designs in the history of the submarine, the **Type XXI** was to set standards until the introduction of the nuclear boat a decade later. Though both closed-cycle turbines and diesels had been introduced, both still needed development, so a stopgap high-power electric boat was produced, using mostly established technology. With the lower pressure hull packed with high power-density cells, the Type XXIs could, for the first time, develop more power submerged than surfaced. Their main propulsion motors were supplemented by low power units for silent manoeuvring.

Like that in the Type XVII, the pressure hull of the Type XXI was of 'double-bubble' cross section, though externally framed. It was prefabricated in eight sections at a variety of sites, being brought together for final assembly at the shipyard. The external framing increased volume and facilitated the addition of a hydrodynamically clean outer skin. Construction was all-welded for a target of three boats per week in an ambitious programme to produce an eventual 1,500 units (U-2500 to U-4000). Most other submarine programmes were curtailed or cancelled to this end.

The Type XXIs were designed to spend their full patrol time submerged, so the snort was used mainly to run diesels for battery recharge. Habitability was greatly improved, with air-conditioning and air-regeneration apparatus.

The only guns were paired automatic weapons set into the forward and after profiles of the elongated fin. A combination of active and passive sonars was used to provide a full torpedo-firing solution without recourse to the periscope. Two proposed but unbuilt variants, the **Type XXIB** and **Type XXIC**, would have increased the number of torpedo tubes from six to 12 and 18 respectively by the insertion of extra sections into the hull. Fortunately for the Allies, the Type XXI never became fully operational. Several were sunk, all by aircraft and in home waters.

Specification

Type XXIA

Type: ocean-going submarine

Displacement: 1,621 tons surfaced and 1,819 tons submerged

Dimensions: length 76.70 m (251 ft 8 in); beam 6.62 m (21 ft 9 in); draught 6.20 m (20 ft 4 in)

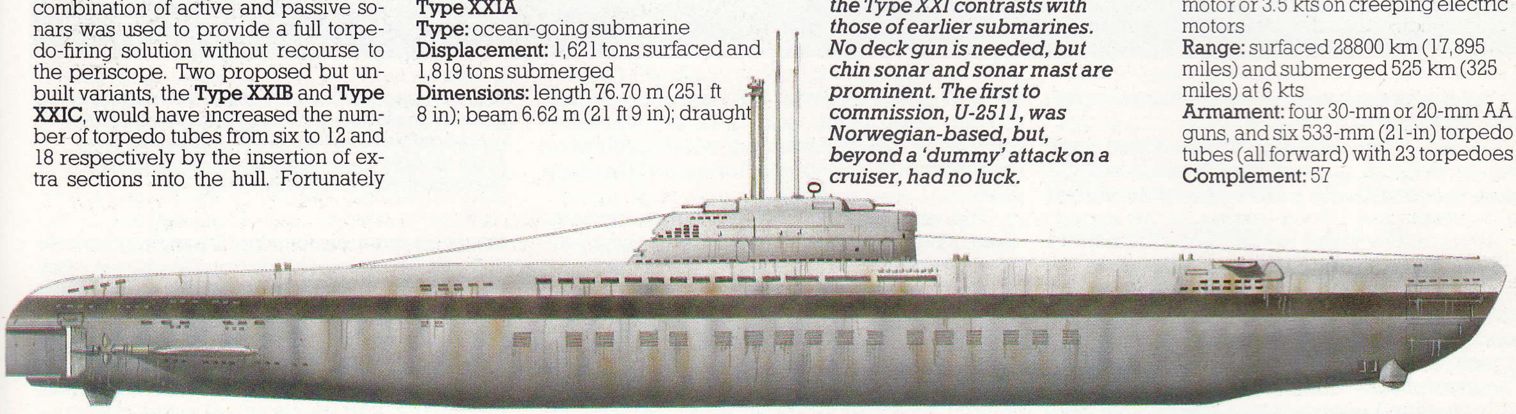
Propulsion: surfaced diesels delivering 4,000 bhp (2985 kW) and submerged electric motors delivering 5,000 hp (3730 kW) or electric motors delivering 226 hp (169 kW) to two shafts

Speed: surfaced 15.5 kts and submerged 16 kts on main electric motor or 3.5 kts on creeping electric motors

Range: surfaced 28800 km (17,895 miles) and submerged 525 km (325 miles) at 6 kts

Armament: four 30-mm or 20-mm AA guns, and six 533-mm (21-in) torpedo tubes (all forward) with 23 torpedoes

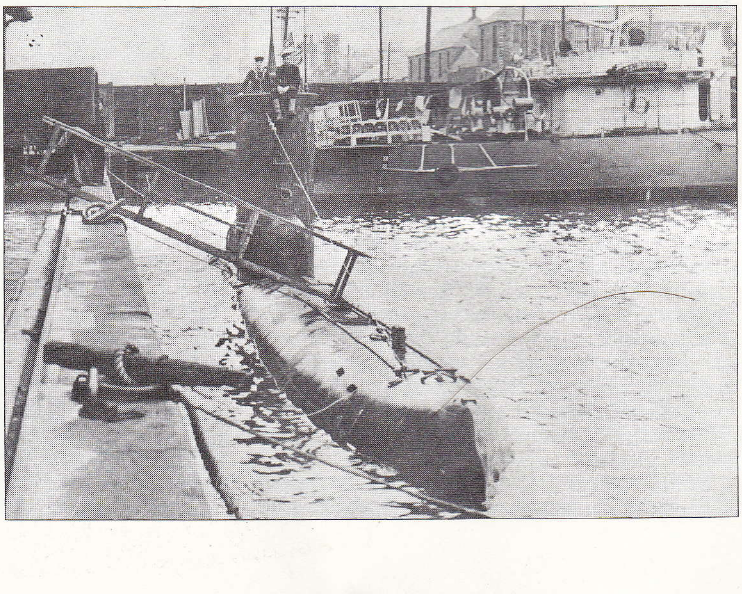
Complement: 57



Optimized for submerged performance, the profile of the Type XXI contrasts with those of earlier submarines. No deck gun is needed, but chin sonar and sonar mast are prominent. The first to commission, U-2511, was Norwegian-based, but, beyond a 'dummy' attack on a cruiser, had no luck.

GERMANY

Type XXIII

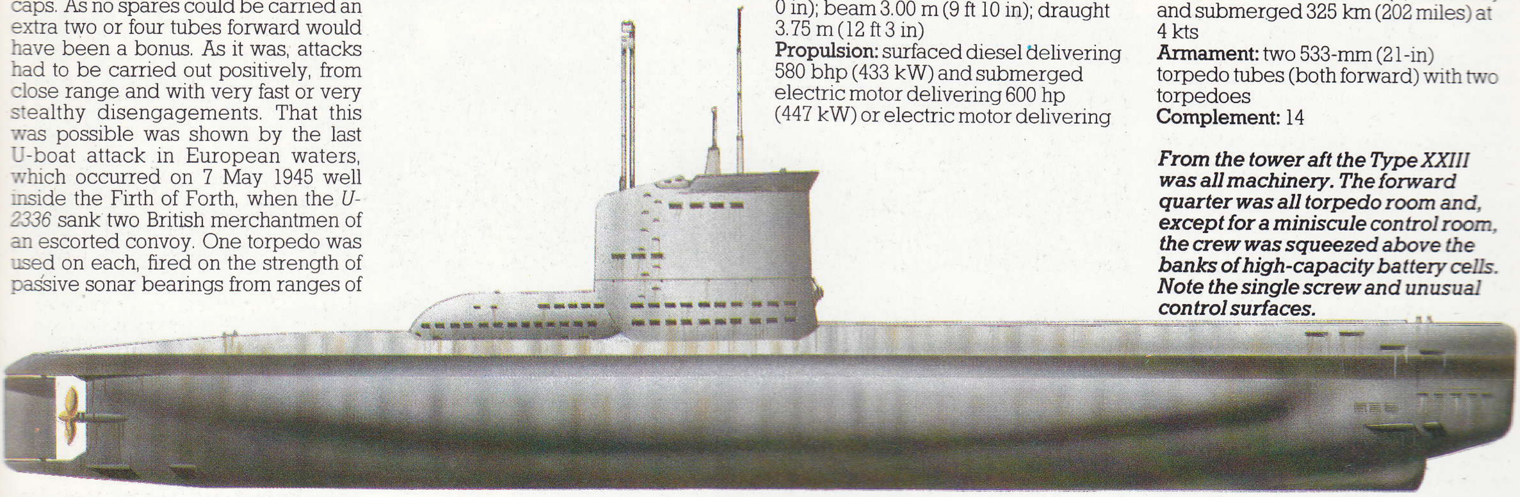


The very small size of the German Type XXIII is apparent from this view of U-2326 alongside a Dundee quay in May 1945. Few fittings protrude to spoil the flow over the very clean hull and tower. Only two bow torpedo tubes were fitted.

Rather than search the Atlantic for convoys it may, in retrospect, have been more rewarding for the German submarine arm to develop tactics to tackle them at their known points of arrival and departure, despite the likely concentrations of escorts. A suitable vehicle would have been the **Type XXIII**, small and agile for shallow water operations and, like its larger cousin the Type XXI, packed with high-capacity battery cells for maximum underwater speed. Its hull had the 'double-bubble' cross section over the forward half but was internally framed and prefabricated in four sections. The partial-length lower hull contained both batteries and some ballast and fuel capacity. A departure was the near abandonment of outer casing except in the transitional zones and this, together with a very low reserve buoyancy (the difference between surfaced and submerged displacements was only 24 tons) allowed for rapid crash-dive, times of less than 10 seconds being recorded. Even smaller than the Type XVII Walter boats, the Type XXIIIs also had a single shaft but a propeller proportionately larger in diameter for greater propulsive efficiency.

Though the boat was designed to operate submerged, its silhouette on the surface was very small, being little more than the slim tower with the attached low casing that enclosed the snort induction and engine exhaust arrangements. No guns were carried and, oddly, only two torpedo tubes. With no space inboard for orthodox loading, the boat needed to be trimmed by the stern to expose the bow caps. As no spares could be carried an extra two or four tubes forward would have been a bonus. As it was, attacks had to be carried out positively, from close range and with very fast or very stealthy disengagements. That this was possible was shown by the last U-boat attack in European waters, which occurred on 7 May 1945 well inside the Firth of Forth, when the *U-2336* sank two British merchantmen of an escorted convoy. One torpedo was used on each, fired on the strength of passive sonar bearings from ranges of less than 500 m (545 yards). By this time 62 type XXIIIs had entered service and their only losses had been to aircraft; it was fortunate for the Allies that the enemy's training and dedication no longer matched his technology.

Specification
Type XXIII
Type: coastal submarine
Displacement: 232 tons surfaced and 256 tons submerged
Dimensions: length 34.10 m (112 ft 0 in); beam 3.00 m (9 ft 10 in); draught 3.75 m (12 ft 3 in)
Propulsion: surfaced diesel delivering 580 bhp (433 kW) and submerged electric motor delivering 600 hp (447 kW) or electric motor delivering 35 hp (26 kW) to one shaft
Speed: surfaced 10 kts and submerged 12.5 kts on main electric motor or 2 kts on creeping electric motor
Range: surfaced 2500 km (1,555 miles) and submerged 325 km (202 miles) at 4 kts
Armament: two 533-mm (21-in) torpedo tubes (both forward) with two torpedoes
Complement: 14



From the tower aft the Type XXIII was all machinery. The forward quarter was all torpedo room and, except for a miniscule control room, the crew was squeezed above the banks of high-capacity battery cells. Note the single screw and unusual control surfaces.

ITALY

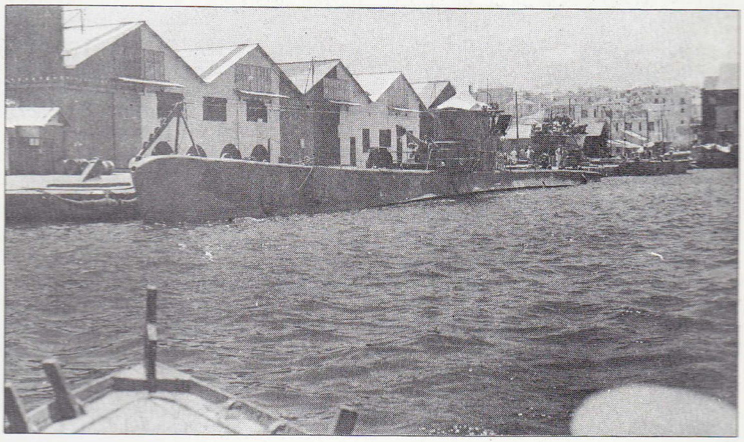
'Sirena', 'Perla', 'Adua' and 'Acciaio' classes

Dating from a period of great expansion for the Italian navy's submarine arm, the 12 **'Sirena' class** submarines were known also as the **'600' class** boats. This figure was indicative of their standard surface displacement and, though the final design exceeded it by a considerable margin, they proved very handy boats for the constricted conditions of the Mediterranean. Their detail design was greatly influenced by that of the preceding 'Argonauta' class, but, as they were laid down before the latter's entry into service, they did not benefit from working experience. Simple and robust, they were heavily used and suffered accordingly, only one surviving beyond the armistice of September 1943.

Ten almost identical derivatives, the **'Perla' class**, followed on. Two of these, *Iride* and *Onice*, served somewhat controversially under Spanish Nationalist colours during the Spanish Civil War. During World War II, the *Iride*, together with the *Ambra*, were converted to carry SLC human torpedoes. The latter boat had already distinguished herself when, two days after the Battle of Cape Matapan, she had sunk the British cruiser HMS *Bonaventure*. Once converted, she went on to attack the harbour at Algiers in December 1942, heavily damaging four ships totalling 20,000 gross registered tons.

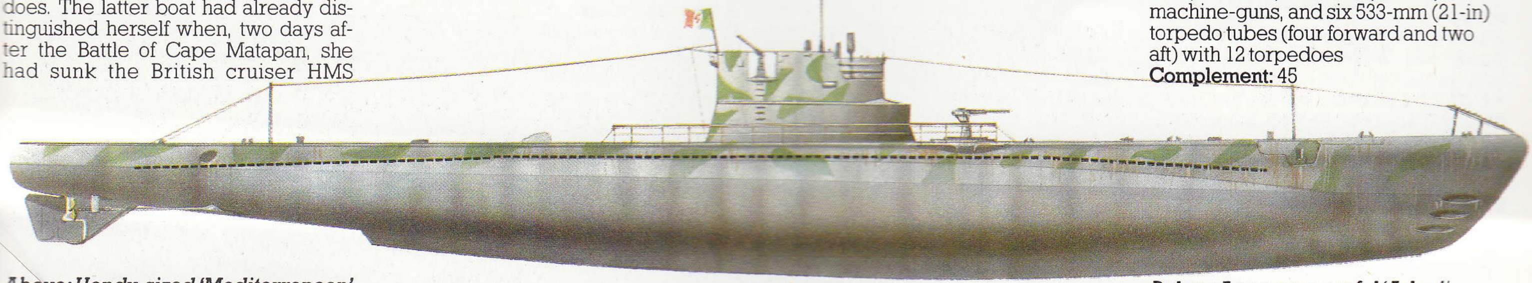
Yet another virtual repeat class had followed in the 17 **'Adua' class** boats, launched 1936-8. Two of these also were converted to carry SLCs and one of these the *Scirè*, was particularly successful. She attacked Gibraltar on no less than four occasions, the raid of September 1941 accounting for two ships, including the auxiliary tanker *Denbydale*. Her greatest coup, however, was in December 1941 when her three SLCs put the battleships HMS *Queen Elizabeth* and HMS *Valiant*, together with a tanker, on the bottom of Alexandria harbour. She was finally sunk by the anti-submarine trawler *Islay* outside Haifa in August 1942.

The final expression of the '600' type was in the enlarged 13-boat **'Acciaio' class** of 1941-2.

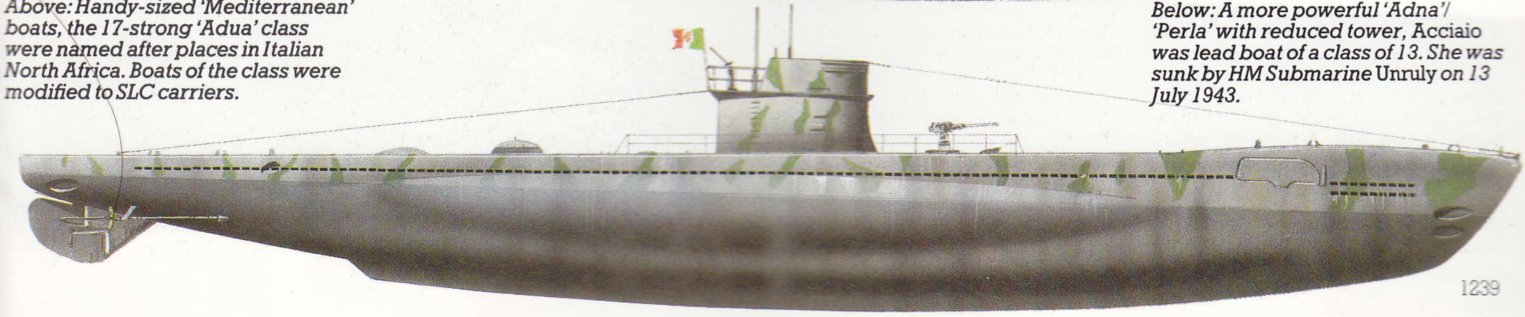


The Italian submarine Perla at Beirut after capture in 1942. The shadow accentuates the unusual tumblehome of the casing.

Specification
'Sirena' class
Type: sea-going submarine
Displacement: between 679 and 701 tons surfaced and between 842 and 860 tons submerged
Dimensions: length 60.18 m (197 ft 6 in); beam 6.45 m (21 ft 2 in); draught 4.70 m (15 ft 5 in)
Propulsion: surfaced diesels delivering 1,200 bhp (895 kW) and submerged electric motors delivering 800 hp (597 kW) to two shafts
Speed: surfaced 14 kts and submerged 8 kts
Range: surfaced 9000 km (5,590 miles) at 8 kts and submerged 135 km (84 miles) at 4 kts
Armament: one 100-mm (3.9-in) gun, two (later four) 13.2-mm (0.52-in) machine-guns, and six 533-mm (21-in) torpedo tubes (four forward and two aft) with 12 torpedoes
Complement: 45



Above: Handy-sized 'Mediterranean' boats, the 17-strong 'Adua' class were named after places in Italian North Africa. Boats of the class were modified to SLC carriers.



Below: A more powerful 'Adna'/ 'Perla' with reduced tower, Acciaio ***was lead boat of a class of 13. She was sunk by HM Submarine*** Unruly ***on 13 July 1943.***

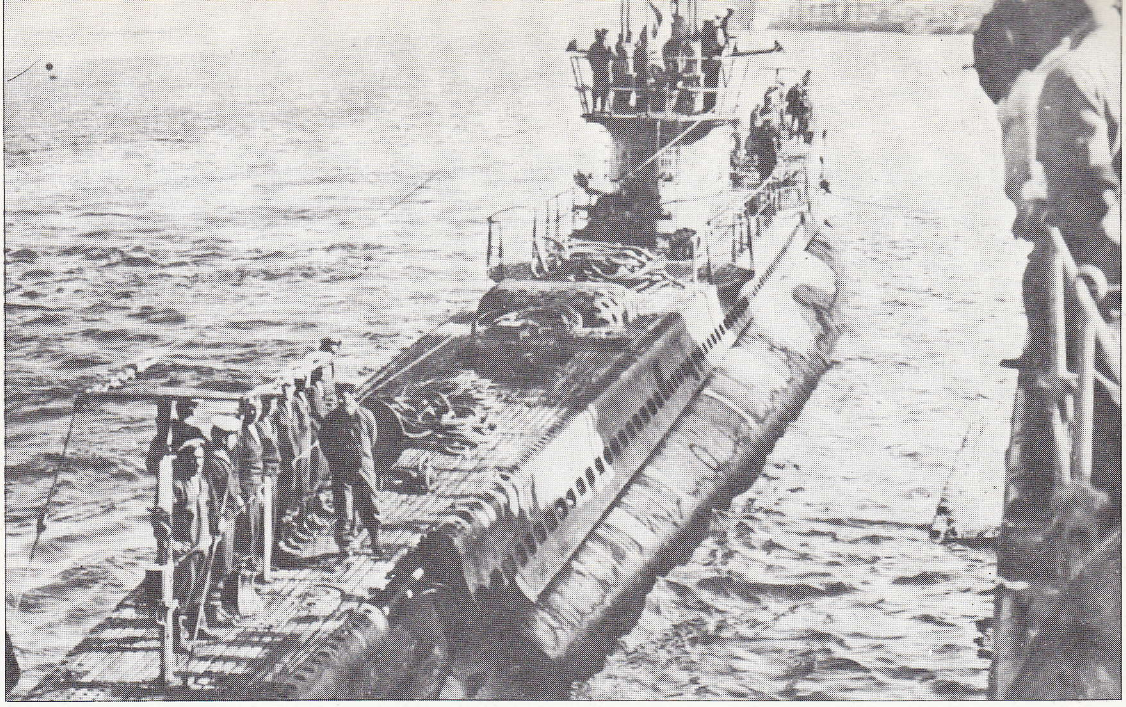
ITALY

'Cagni' class

It is not clear how the Italian navy, with minimal commitments outside the Mediterranean, could justify investment in submarines for ocean warfare. Italy's merchant marine, while of reasonable size, could not be protected on a worldwide basis by Italy's surface fleet, which was geared to short-endurance, high-speed undertakings, so coherent operations in the defence of trade were out of the question, even against the rival neighbour France. Despite this, the four **'Cagni' class** submarines were all laid down in September and October 1939 on the outbreak of hostilities between Germany and the Anglo-French alliance. As these submarines were aimed specifically at long-range commerce raiding, one can only speculate that Italy, as yet uninvolved, saw involvement against the maritime powers as only a matter of time.

The 'Cagnis' were the largest attack boats yet built for the Italian navy and, interestingly, were armed with small 450-mm (17.7-in) torpedoes. Though these were longer than the standard 450-mm (17.7-in) weapons, enabling them to carry a warhead of 200 kg (441 lb) in place of the more usual 110 kg (243 lb), this payload was still considerably less than the 270 kg (595 lb) of the larger 533-mm (21-in) torpedoes. As the torpdoes were for use primarily against 'soft' targets, however, this was judged acceptable, together with their lack of range. The bonus for this compromise was the ability to carry 36 torpedoes, the eight tubes forward and six aft permitting large spreads to enhance chances of success. An unusual feature was that torpedoes could be transferred from one end of the boat to the other. Two large deck guns were also carried to conserve torpedoes.

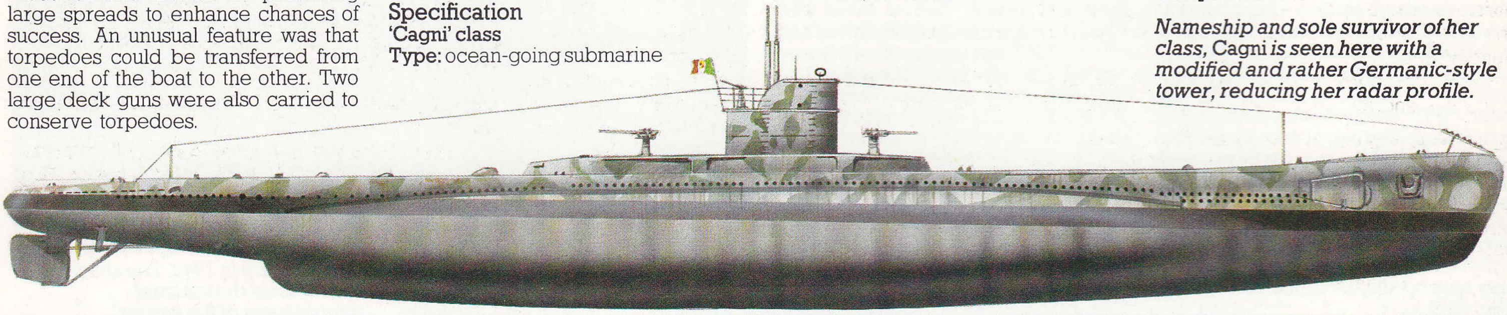
Unfortunately for Italian plans, the Mediterranean sea war required the keeping open of the vital North Africa supply route. Following heavy surface losses, the navy pressed large submarines into this service. In completing 15 trips, three of the four boats in the class were sunk in only three months. Only the name boat *Ammiraglio Cagni* worked as designed, but unsuccessfully, sinking less than 10,000 gross registered tons in two long patrols.



Ammiraglio Cagni *returns from sea with a damaged after casing. The heavy armament of two 100-mm and four 13.2-mm guns can be seen, also the generally bulky appearance typical of most Italian ocean-going boats.*

Specification

'Cagni' class
Type: ocean-going submarine
Displacement: 1,680 tons surfaced and 2,170 tons submerged
Dimensions: length 87.90 m (288 ft 5 in); beam 7.76 m (25 ft 6 in); draught 5.72 m (18 ft 9 in)
Propulsion: surfaced diesels delivering 4,370 bhp (3260 kW) and submerged electric motors delivering 1,800 hp (1345 kW) to two shafts
Speed: surfaced 17 kts and submerged 8.5 kts
Range: surfaced 20000 km (12,425 miles) at 12 kts and submerged 200 km (124 miles) at 3.5 kts
Armament: two 100-mm (3.9-in) guns, four 13.2-mm (0.52-in) machine-guns, and 14 450-mm (17.7-in) torpedo tubes (eight forward and six aft) with 36 torpedoes
Complement: 82



Nameship and sole survivor of her class, Cagni *is seen here with a modified and rather Germanic-style tower, reducing her radar profile.*

ITALY

'Archimede' class

The four **'Archimede' class** submarines were enlargements of the preceding 'Settembrini' design with ballasting rearranged to improve bunker capacity. An extra gun was also fitted, in keeping with the boats' 'ocean' role. All were launched in 1934 and, as part of their covert support of the Nationalist cause during the Spanish Civil War, the Italians transferred two to Spanish colours. These were the *Archimede* and the *Torricelli* and, to 'conceal' their transfer, two of the follow-on 'Brins' assumed their names. The three classes of boat formed a closely-related group, used extensively in colonial work.

That part of the Italian navy stationed in the Red Sea in June 1940 was cut off from the homeland and severely handled by the British as a threat astride the route from the Suez Canal eastward. The *Galilei* sank a Norwegian tanker less than a week after the outbreak of hostilities and announced her position further only two days later by stopping a neutral for examination. On the following day she was intercepted by the British anti-submarine trawler *Moonstone*, which inflicted damage that caused the boat to be filled with noxious fumes. Unable to dive, she fought it out on the surface. Far larger, faster and more heavily armed than her opponent she should have been successful had not the *Moonstone* shot up every gun's crew that emerged topside. With most of its officers dead, the demoralized crew surrendered. Captured, the boat assumed the British pennant P711 until her eventual disposal in 1946.

Galilei's replacement *Torricelli* was also apprehended by British forces. Forced to the surface near Perim Island, she engaged in a gun action with three 'K' class destroyers and a sloop. She was, inevitably, sunk but not before she had hit both the sloop and the destroyer HMS *Khartoum*. The hit on the latter was on one of the banks of torpedo tubes and, apparently, caused a compressed air explosion followed by the detonation of a torpedo warhead. The ship was destroyed.

Specification

'Archimede' class
Type: sea-going submarine
Displacement: 985 tons surfaced and 1,259 tons submerged
Dimensions: length 70.50 m (231 ft 4 in); beam 6.83 m (22 ft 5 in); draught 4.10 m (13 ft 6 in)
Propulsion: surfaced diesels delivering 3,000 bhp (2235 kW) and submerged electric motors delivering 1,300 hp (970 kW) to two shafts
Speed: surfaced 17 kts and submerged 8 kts
Range: surfaced 19000 km (11,805 miles) at 8 kts and submerged 195 km (121 miles) at 3 kts
Armament: two 100-mm (3.9-in) guns, two 13.2-mm (0.52-in) machine-guns, and eight 533-mm (21-in) torpedo tubes (four forward and four aft) with 16 torpedoes
Complement: 55

The 'Archimede' class submarine Galilei *is seen about to be taken in tow by the British destroyer* Kandahar. *Noxious gases filled the boat and caused her surrender.*

US Army

Part 2

The US Army now consists of all-regular personnel, and good rates of pay and the introduction of new equipment such as the M1 Abrams MBT has meant that almost all units are up to full strength and the Army can be more selective in its recruitment. These troops are in West Germany in 1983.

Organization

The US Army is divided into 14 major commands. On a functional basis, it is perhaps more illuminating to think of the army as divided into two basic branches, the Arms and the Services, although these have some overlapping responsibilities.

The Arms, listed in order of precedence, are the Infantry, the Corps of Engineers, Air Defense Artillery, Field Artillery, Armor, the Signal Corps, the Military Police, and Army Intelligence.

The Services are the Adjutant General's Corps, the Finance Corps, the Quartermaster Corps, the Army Medical Department, the Chaplains, the Judge Advocate General's Corps, the Ordnance Corps, the Chemical Corps, and the Transportation Corps.

Overlap occurs with the Corps of Engineers, the Military Police, and the Signals Corps, for these are considered both Arms and Services because they have a dual combat and service function. Some entities fall into neither category, such as the Army Intelligence and Security Command (INSCOM) and Army Aviation, numerically the largest 'air force' in the world, but not permitted to operate fixed-wing combat aircraft, which have become the concern of the US Air Force.

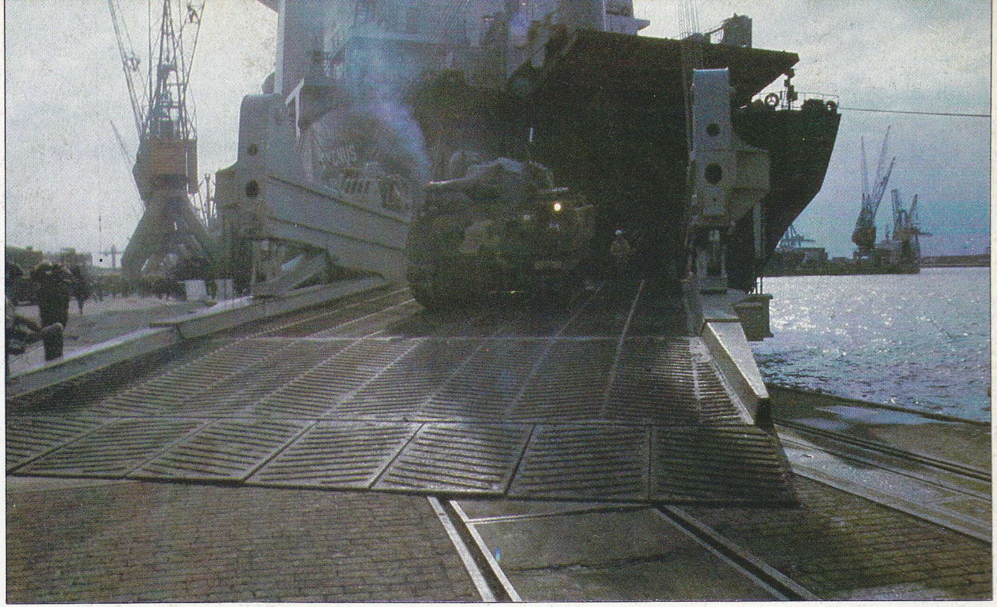
Operationally, the US Army is formed of divisions, grouped into corps along three basic lines. These divisions are the four armoured divisions, six mechanized infantry divisions, and four infantry divisions. There is also a single paratroop division, the 82nd Airborne, considered the army's crack fighting force.

Each armoured division has five or six tank battalions and four mechanized infantry battalions. Each mechanized infantry division possesses four tank battalions and five mechanized infantry battalions; in addition there are three or four artillery battalions, a helicopter battalion, an air-defence missile battalion, an air cavalry squadron, and supporting units. Each infantry division has one tank battalion, six mechanized infantry battalions and, usually, six or more infantry battalions. The 82nd Airborne is formed of three brigades, each with three parachute battalions and an artillery battalion.

The above are basic outlines. Some divisions have more units assigned, others are merely at cadre strength. The infantry and mechanized infantry divisions have National Guard components and some divisions rely on the Reserves to fill out their totals.

National Guard units, and there are 3,285 of them, represent the individual states' role in contributing to national defence. Under control of state governors until activated as part of the regular army, National Guard units are theoretically required only

Equipment is unloaded from a Lockheed C-130 Hercules of Military Airlift Command (MAC) during the 1983 'Reforger' exercises. In time of war there would be insufficient C-130, C-141 and C-5 aircraft to go around, and much equipment would still have to come across the Atlantic by sea.



An M163 20-mm Vulcan self-propelled anti-aircraft gun is driven off a Cygnus vehicle cargo ship (AKR). Two ships of this class were chartered to the Military Sealift Command for a five-year period from 1981, at a total cost of over $135 million. Vehicles are unloaded via the stern.

in times of national emergency, but have been mobilized for internal policing and disaster relief functions. Full mobilization of the National Guard would produce two armoured divisions, a mechanized infantry division, five infantry divisions and 22 independent brigades (four armoured, eight mechanized infantry and 10 infantry) of which four would join regular divisions. They would in addition form four armoured cavalry regiments, eight air-defence battalions, and supporting units. Included are five independent tank battalions, two mechanized infantry battalions, 50 artillery battalions, four anti-tank battalions armed with TOW missiles, an infantry reconnaissance group for use in the Arctic, two Special Forces groups, and Army Aviation units that fly 2,568 aircraft.

Every year 49,000 US Army Reserves serve temporarily with regulars, adding 3,410 units and 556 aircraft. The Reserves include 12 training divisions, a mechanized infantry division, two independent combat brigades, and 67 support battalions. Not all Reserve units are up to full strength, some being cadres only.

To back up conventional forces, the US Army maintains at full strength nine artillery groups, each with from 12 to 16 artillery battalions, and four anti-aircraft artillery (AAA) groups. There is a single independent armoured brigade and four independent infantry brigades. The spirit of the old horse cavalry is kept up by one independent air cavalry brigade and three armoured cavalry regiments.

The US Army's heavy punch comes from four Pershing missile battalions, one of which is a training battalion capable of use in the field if required. To back these longer-range units are eight Lance battalions. Pershing and Lance can be fitted with nuclear warheads, and will soon be joined in inventory by Patriot air-defence missiles in nine battalions.

Also distinct from conventional field units are the US Army's three Special Forces groups and two Ranger battalions. Men from these elite units were included in the tri-service 'Blue Light' outfit which made the Iranian rescue attempt. Special Forces and Rangers are the US Army's 'SAS' and train for everything from foiling airline hijackings to dropping behind the lines into Czechoslovakia.

Army Aviation supports the ground fighters, and its units are assigned to various headquarters for reconnaissance, scouting, tactical support, casualty evacuation, and other work. The army operates Beech RU-21D 'Guardrail' electronics aircraft on snooping missions. A new generation of helicopters is typified by the Sikorsky UH-60A and Hughes AH-64.

Apart from the field forces in its order of battle, the US Army has units in Greece, Italy, the Netherlands and Turkey, plus small units in the United Kingdom. To back up its major commitment in Korea, base and support personnel are stationed in Japan.

Of special interest, especially to those pondering the army of the 21st century, is the 9th Infantry Division at Fort Lewis, Washington. Part of the RDJTF, trimmed of fat, beefed-up on weaponry, the 9th Infantry Division is an experimental and trials division known as the High Technology Test Bed (HTTB). It is the model for the projected Division '86, a new type of US Army division scheduled to take to the field in 1986.

Equipment

Just about every item in US Army inventory is superb, though some raise the eyebrows of Congressional watchdogs like Michigan Senator William Proxmire, a defence expert troubled over rising costs. The American soldier has always gone to war with the best that his nation can provide, and no effort is spared to guarantee that he will not find his equipment wanting. It does not always work: some items prove faulty under the stress of in-service or combat experience. But as a rule, strict research and development standards and rigorous testing eradicate flaws an item may conceal. While gratifying for the soldier, this has its price. Some weapon systems are too complex, where a simpler design would do. Some are 'gold-plated' to a degree to cause even the exchequer of the richest nation on Earth to blanch.

An example, say critics, is the Hughes AH-64 Apache. This armed helicopter resulted from long development and research to counter the threat of Warsaw Pact armed helicopters (such as the latest Mil 'Hind' variants) and of massed armour attack. From studies, the AH-64 design was chosen and from it a superb combat helicopter has emerged. The two-seat AH-64 can operate in all weather and has important 'survivability' features, including complex navigation systems, pilot aids and armour. As armament, the AH-64 has an inbuilt 30-mm Chain Gun, 70-mm (2.75-in) rocket in pods for ground-fire suppression, and Hellfire anti-tank missiles. Sensors and electronic devices for target-seeking sprout from all parts of the airframe. The first AH-64's have entered service but with a price tag close to $15 million each. While the US Army has an initial requirement for 112 AH-64s, it is unlikely to get even that many if current noises from Congressional budget-watchers are anything to go by, especially since the AH-64 is intended to knock out helicopters and tanks costing far less.

An even louder brouhaha has arisen over the divisional air defence system (DIVADS), inspired by the Soviet ZSU-23-4 air-defence cannon. DIVADS is a radar-guided, twin 40-mm gun system mounted on an M48A5 tank chassis, and is intended to guard field forces against armed helicopters and fighter-bombers. Critics say it has two problems which compromise some weapons systems: it is too complicated to operate and, at $1.5 million it costs too much.

Other examples of the over-elaborate or of 'gold-plating' can be cited, but in the main the US Army is well served by American defence industries, who are now the arsenal of the non-Communist world. What the US Army adopts, other nations adopt, aware that supply, back-up and spares will be forthcoming.

Suppliers of equipment for the US Army include a few which are virtually state-owned. For example, artillery comes almost exclusively from Federal arsenals at Rock Island and Watervilet. Most items, however, come from the nation's well-known private contractors such as Chrysler, Ford, McDonnell Douglas, and so on.

When the US Army assumes a new weapons system, as a rule the replaced equipment goes to the National Guard. But in recent years the National Guard has begun to receive some new equipment ahead of the regular army, a case in point being the M901 Improved TOW anti-tank missile vehicle provided to National Guard units before it was issued to troops in Germany. Most of the equipment of the National Guard and Reserves remains a generation behind that of the regular army.

M60 MBTs and M151 (4×4) light vehicles, stockpiled somewhere in West Germany. These are kept in top condition and are ready to move as soon as their crews arrive by air from the United States. Similar stockpiles of equipment are held on ships in the Middle East.

12 Pass